SCIENCE

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CONTENTS:

SOME PROBLEMS ABOUT TO CONFRONT ASTRONOMERS OF THE TWENTIETH CENTURY.

Members of the New York Academy of Sciences, Ladies and Gentlemen: The nineteenth century has shown vigorous development in all branches of science, and in none more than in astronomy. The effective work of numerous observers and mathematicians has lifted us to greater heights of knowledge, making visible and clear many things previously discerned dimly. But the elevation has also extended our horizon, and the boundaries of knowledge appear 'infinitely infinite.' This evening I shall not make any attempt to sketch the details, or even the general features of the view before us, as we stand at the end of the century, looking down from the elevated position the scientific workers in astronomy enable us to occupy. I shall content myself with a much narrower survey, selecting here and there some especial part of the field before us, with the desire of stating briefly what has been done in that field and in what condition it now stands.

From the point of view of the practical astronomer the stars are so many signal lights marking the 'milestones on the great celestial highway traversed by the planets, as well as on the byways of space occasionally pursued by comets.' If we desire to know the position of a planet or a comet on

*Address of the retiring President of the New York Academy of Sciences, March 30, 1896.

the celestial vault, we must observe how far such a body is separated in two directions from the neighboring stars, and evidently we must know where these stars are situated in the heavens. A few thousand stars are sufficient for this purpose provided they are determined in position with the highest precision.

But the astronomer is also deeply interested in 'the sublime problem of the construction of the heavens' and many thousands of stars must be exactly located to aid in solving this problem. Moreover, there is need of a general rollcall of all the stars visible in ordinary telescopes. Such a 'rollcall' or 'index' gives the positions of the stars with an accuracy less than the highest precision requires, and is mainly useful as a basis of work for the more accurate catalogues. The work of determining the positions of stars on the sky-dome is the most important and fundamental operation in practical astronomy. During the present century this foundation work of astronomy has been carried on 'with a zeal and success by which all previous efforts are dwarfed into insignificance.'

The great German astronomer 'the unrivalled Bessel' from 1821 to 1833 made some 75,000 observations, by which the number of fairly well determined stars was increased to above 50,000. His assistant and successor, Argelander, who gave up finance for astronomy, using a glass only two and a half inches in diameter, recorded 324,189 stars down to the 9½ magnitude. This number included all the stars of the magnitude named, visible in the northern hemisphere of the heavens, and in addition a small zone about two degrees wide, south of the celestial equator. Schönfeld continued the survey at Bonn, down to the southern tropic.

In 1882 a photograph taken of the great comet of that year, by Dr. Gill at the Royal Observatory at the Cape of Good Hope, showed so many stars that it was determined to use photography in completing the Bonn survey to the south pole. The exposure of the plates in duplicate required four years from 1885–89. But this was the least laborious part of the great work. These plates had to be measured and the measurements reduced so as to obtain the proper positions of the stars on the sky. Prof. Kapteyn, of Gröningen, lately completed this task, and the catalogue from the plates is now passing through the press. The catalogue will contain about 350,000 stars to the tenth magnitude. A considerable part of the southern sky covered by the surveys of Schönfeld and Gill was examined also by Dr. Gould. Through 'unceasing labors during his fifteen years' residence a Cordoba,' in the Argentine Republic, an acquaintance of some 73,160 stars down to the 9½ magnitude was brought about. The Argentine General Catalogue was published in 1886 and contained the accurate places of 32,448 southern stars. These and other catalogues put us in possession of a list of stars fairly well determined in position, numbering nearly 700,000. Catalogues of much greater precision, giving the positions of a smaller number of stars with the highest accuracy, have been prepared after many years of observation and calculation by the noted observatories of the world.

As an example of coöperation in modern science, I ought to mention that the first organized effort for determining star positions with the highest precision was made by the German Astronomical Society in 1865. The scheme, now practically finished, was to fix the positions accurately of about 100,000 stars on Argelander's list and some 30,000 from Schönfeld's. Thirteen observatories were interested in this great work, each being assigned a 'zone;' two in this country—Harvard College Observatory and the Dudley Observatory at Albany.

The work of Lewis M. Rutherfurd, of this city, an honored member of this Academy for many years, in photographing stellar clusters and in measuring the plates with a machine of his own devising, was the first serious attempt to use photography in getting the exact relations of stars to each other. The recent publications of the Columbia College Observatory show unmistakably that from these measures relative positions of the highest precision are obtainable. The invention of dry plate photography has made the photographic work of the astronomer of to-day much more expeditious, and enables him to secure many more stars on his plates with a given time of exposure. The last years of this century witness the carrying out of a gigantic plan for making an enormous catalogue of the highest precision by the aid of photography and supplementing this catalogue by a series of charts.

On April 16, 1887, there met in Paris 56 delegates of 17 different countries, to discuss ways and means of carrying out this grand photographic work. The final decision was to construct a photographic chart of the heavens of all the stars down to the 14th magnitude. On these plates will appear, it is estimated, some 20,000,000 stars. Methods are now being devised to reproduce accurately these chart plates. It was decided also to supplement these chart plates, made with an exposure of 40 minutes, by plates of shorter exposures, from measurements of which, with machines of the highest precision, a catalogue is to be prepared. These catalogue plates show the stars down to the 11th magnitude, and the number of stars may reach two millions. Twenty-two thousand plates (duplicated and overlapping) will be necessary for the catalogue. The work has been going on for several years at 18 observatories throughout the world (except in the United States) and the photographic part will soon be finished. The measurements of the plates and the calculations based thereon are also being carried on at Paris, Potsdam, Greenwich and elsewhere. Judging from the work already done, we may confidently expect that nearly all the results will be ready for printing in about ten years. The astronomers of the 20th century will then be in possession of material which will aid them in studying the problems connected with the construction of the universe of stars.

The number of stars around us increases with every augmentation in telescopic power, and in time of exposure of photographic plates. The largest telescopes will show perhaps more than 60,000,000 stars. The long exposure photographs (say 12 hours) would show many millions more. M. l'Hermite has 'computed the population of the stellar universe from his valuation of stellar light power and finds it, on the assumption that the scattering of the stars is everywhere just as it is in our own neighborhood, to be sixty-six thousand millions!' This result is ingenious and interesting, but depends for its value on the above assumption.

The task of sidereal astronomy—a stupendous one—is this then: 'to investigate the nature, origin and relationships of millions of stars; to inquire into their movements among themselves and that of our sun among them,' and 'to assign to each its place and rank in the universal order.'

Among the great number of interesting problems in sidereal astronomy, let me select two or three of the most important. The catalogues of the highest precision enable the astronomer to determine the positions of various stars at widely different dates. This requires that the catalogues used should be made up from observations at those dates. Now comparing the positions of a star at any two dates a difference will be found depending in amount on the lapse

of time. The star, therefore, has apparently moved from the first to the second position. But there are several things to be taken into account before we can say how much the star has moved. The effects of precession and nutation and the aberration of light must be eliminated. When this is done it is found that only a very few stars have an accurrately determined motion of their own among their fellows. Schönfeld, of Bonn, has published a list of 83 stars that have a proper motion in a year greater than 1″ of arc, *i. e.*, greater than the angle subtended by three-tenths of an inch to the eye placed one mile away. Only 83 of all the hosts of stars are known to move at right angles to our line of sight 1″ of arc or more in one year.

The star which has the greatest proper motion so far known is No. 1830 of Groombridge's Catalogue. This star moves 7″ of arc in a year. The star is so far away that this small apparent motion across our line of sight means, if the distance has been accurately determined, a very startling linear velocity of more than 230 miles in a second, a speed 'uncontrolable, according to Newcomb, by the combined attractive power of the entire sidereal universe.'

Groombridge 1830 is not the only 'runaway' star in the list, there are several others; Clerke remarks "the fact then confronts us that not a few of the stars possess velocities transcending the power of government of the visible sidereal system. Is that system threatened with dissolution, or must we suppose the chief part of its attractive energy to reside in bodies unseen, because destitute of the faculty of luminous radiation? No answer is possible; conjecture is futile. We are only sure that what we can feebly trace is but a part of a mighty whole, and that on every side our imperfect knowledge is compassed about by the mystery of the Infinite."

When we consider proper motions less in amount than 1″ a year the list swells in number to over 3,000. The astronomer of the XXth Century will be able to determine the proper motions of thousands of other stars, using the superb catalogues constructed in this century. In studying this problem the aid of the spectroscope has been called in, and with that wonderful instrument it has been found possible to measure the velocity of quite a number of stars in the line of sight, either directly from us or toward us. At Potsdam and at Greenwich and elsewhere, by the use of measurements or photographs of stellar spectra or by visual observations, Aldebaran, the brighest star in the constellation of Taurus, has been found to be moving from the earth at the rate of 30 miles a second. The Greenwich observers tell us that the North Star is moving toward us at the rate of 16 miles a second. Vogel, at Potsdam, places the motion of Arcturus at 45 miles a second from the earth. When we combine the motion in the line of sight with the motion at right angles to that line, we can discover the real motion in space, its amount and direction. At the Lick Observatory Mr. Campbell has proposed to determine with the spectroscope in what direction the solar system is moving among the stars.

The motion of our solar system among the stars has interested astronomers for many years. Sir Wm. Herschel first investigated this problem a century ago. The fundamental principle of the investigation is this: Those stars which lie in the direction in which we are going will appear to open out from each other, while those in the part of the sky that we are leaving will close up behind us. Since Herschel's time the materials for investigation have been greatly augmented. An examination of the stellar proper motions has been made by many calculators, and especially recently by Prof. Boss, of Albany, and by Mr. Oscar

Stumpe, of Bonn. The results agree as well as we could expect at present in fixing 'the brilliant Vega' as 'the center round which the new determined apexes tend loosely to group themselves.' The general direction of the solar motion is thus fairly well determined. The velocity of this motion has not yet been accurately worked out. Sixteen miles a second is given by some astronomers as a probable value.

The distances of the stars have always excited the curiosity of man. During this century the refined methods for obtaining reliable values have been worked out. Only within the last twenty years have the most accurate values been determined. The solar system to our finite minds seems isolated in space, the *nearest star* being so far away that light traveling at the rate of 186,330 miles in each second of time consumes 4.35 years in reaching the earth. The parallax of α Centauri is 0.″75, *i. e.*, the distance separating the earth from the sun, over 90,000,000 miles, would appear to the eye of an observer on α Centauri, as small as $\frac{2}{10}$ of an inch appears to our eyes at a distance of one mile. This nearest star, α Centauri, is at the head of a list of less than 60 stars whose parallaxes have been determined with all the accuracy, very nearly, at present possible. But the laborious search for measurable stellar parallaxes has not been extensive enough among the millions of stars to make us feel that astronomers have determined certainly even the nearest star. Perhaps it will be found among some of the fainter telescopic stars, or even on the photographic plates, that with long exposure show us stars so faint that we can never expect to see them. Photography has proved itself to be a most valuable aid in this investigation, and from the plates specially made much more is to be expected in the future.

The telescope shows numerous cases in which two stars are so close to each other that they can be separated only by a high magnifying power. These are 'double stars.' The catalogues now enumerate more than 10,000 such couples, and the number known to us is increasing quite rapidly. One of the chief pieces of work in which the largest telescopes are used is in detecting new cases of very faint and exceedingly close doubles. A careful examination has revealed the fact that some 200 or more cases of double stars show that the components are physically connected.

The components revolve about the common center of gravity of the system. When one of the stars is much greater in mass than the other, the second star, usually the fainter, revolves about the larger one. Many of these binary stars as they are called are of great interest. Their times of revolution range from 14 years to 1,500 years. The orbits are comparable with the larger orbits of the solar system, some of them being twice as large as that of the planet Neptune, which, as you will remember, moves in an orbit having a radius of about 2,800,000,000 of miles, and revolves about our sun in 165 years nearly.

There are cases of multiple stars. Epsilon Lyrae is a beautiful quadruple star, composed of two pairs. Each pair makes a slow revolution in a period of over 200 years. It is thought that there is evidence that the two pairs revolve about the common center of gravity of the four stars.

Peters found in 1851 that the apparent irregularities in the movements of the brilliant Dog star Sirius could be fully explained by an orbital revolution in a period of fifty years. Bessel had announced in 1844 that the two bright Dog stars Procyon and Sirius moved in seeming irregular paths, because of the presence of unseen bodies near them. Peters thus vindicated Bessel's prediction. On the 31st of January, 1862, while testing the new 18-inch object glass ordered by the late Pres. Barn-

ard for the University of Mississippi, Alvan G. Clark discovered a faint companion to Sirius. This proved to be in the exact position required by Peters' calculations. For Procyon no companion has been found. Recently there have been found evidences of an unseen body in the system of 70 Ophiuchi, a wide double. These and similar investigations indicate that there may be myriads of systems in space similar to our own. Painstaking observations and exact calculations will, no doubt, reveal many hundreds of these systems during the next century, even before new inventions have increased our seeing power.

The thoughtful observer is struck by the fact that the light of most of the stars does not appear to change; they remain each of them apparently of the same brightness year after year, and so far as we can judge from previous accounts, century after century. The stars are so far away that changes in their light-giving power are in most cases invisible to us. There are, however, now known nearly 400 stars which show a variation in light. Some stars change their brightness slowly and continuously; others fluctuate irregularly, like the wonderful star η Argus in the southern heavens, which was nearly as bright as Sirius in 1843 and decreased in brightness down to the 7th magnitude in 1865. It remained at that magnitude until 1888 and has since been increasing in brightness. Dr. Gill, at the Cape of Good Hope, has been studying the star by the aid of photography during the past few years.

Then there is a class of variables called 'temporary stars.' These blaze out suddenly and then disappear. Such variables are styled, sometimes, 'new stars.' Pickering gives a list of 14 'new stars' discovered since the time of Tycho Brahe in 1572. In this list all but four belong to this century, no temporary star being recorded between 1670 and 1848. Six new stars are recorded as having been discovered since 1886. Two of these in 1895. There is no doubt that a more careful study of the heavens will reveal many more such cases. Several of the stars of this class were brightly visible to the naked eye. They remained visible with fading light for different periods of time. Future investigation may show that these stars will appear again, and thus indicate that they are variables of long period showing such light changes as to place their minima beyond the power of the telescope or even of the photographic plate. Then there are known to be a considerable number of variables whose periods of light changes are well determined. These are most interesting to observe. One class has a period of several months, another class a period which is quite short, and still another class 'in which the variation is like what might be produced if the star were periodically eclipsed by some intervening object.' Great use is now made of photography both of the stars and of their spectra in studying variables. At the Harvard College Observatory the plates taken in Arequipa, Peru, have shown on examination many variables. Pickering states that in two photographs of the cluster Messier 5 taken August 9, 1895, only two hours apart, forty-six variables of short periods were found! In the photographs of stellar spectra the presence of bright hydrogen lines in conjunction with dark lines or dusky bands has led to the discovery of numerous variables. The subject is of growing interest and the further prosecution of the work will add, no doubt, many thousands to the present list which has recently been brought down to date by Dr. S. C. Chandler, of Cambridge.

The study of the sidereal systems presents many problems for the mathematical astronomer, but let us consider some unsolved problems connected with our own system. "The profoundest question growing out of the the-

ory of gravitation is whether all the inequalities in the motion of the moon and the planets admit of being calculated from their mutual attraction." In order to answer the question the astronomer must make the calculations demanded by theory, giving him the positions of the planets considered, and then compare the calculated with the observed place. No complete solution has ever been found even in the case of three bodies, and for the case of a larger number of planets no approximation to an entire solution has been made. The complexity of the problem is due to the fact that "the forces which act upon the planets are dependent upon their motions, and these again are determined by the forces which act on them."

Many great mathematicians from Newton's time till now have given much of their attention to the question of how to surmount the difficulties. The success of the partial solution is attested by the "marvellous accuracy with which sun, moon and planets move in their prescribed orbits." Though the accuracy *is* marvellous, there are two cases of greatest interest especially demanding the attention of the mathematical astronomers. These two cases have to do with the motions of the Moon and of Mercury.

The 'Tables of the Moon,' calculated by Hansen and published in 1857 by the British government, were supposed to provide the astronomer with the means of calculating accurately the position of the moon for a century or more. Prof. Grant, in his 'History of Physical Astronomy,' published in 1852, remarked: "Thus the clouds which for a moment obscured the Newtonian theory of gravitation have been effectually dissipated, and a fresh conquest has been added to the long list of triumphs which adorn its history." The agreement of observed and calculated position from 1750 to 1850 is all that could be desired, but it has been found that previous to 1750 and after 1850 the calculations and observations do not agree closely enough to satisfy the mathematical astronomer. Mr. Stone, of Oxford, has published a table (M. N. R. A. S., LII., No. 7, p. 478) showing the 'mean excess over observation of the moon's tabular place in longitude for the years 1847 to 1891, as computed from Hansen's tables.' It is therein shown that from 1847 to 1863 the calculated longitude differed from the observed by a mean annual value of $-1''.85$ and no law of regular change is apparent. Since 1863 the mean annual error has increased at an average rate of $0''.75$ per annum. The error now amounts to about $20''$, equal to about $\frac{1}{100}$ of the moon's angular diameter.

The lunar tables have been empirically corrected by Newcomb and also by Tisserand and at present the results are satisfactory. However, gravitation seems unable to explain theoretically the movement of the moon's perigee. The mathematical astronomer will no doubt triumph over the new obstacle which presents itself to-day, but, as Tisserand says, a beautiful discovery remains to be made.

Newcomb has stated that "another change not entirely accounted for on the theory of gravitation occurs in the motion of the planet Mercury." Leverrier found "that the motion of the perihelion of Mercury is about $40''$ in a century greater than that computed from the gravitation of the other planets." He attributed this to the attraction of a 'group of small planets between Mercury and the sun.' Newcomb, in his recent work on 'Astronomical Constants,' gives the result of an examination of this hypothesis as well as of several others. He concludes (1) "that there can be no such non-symmetrical distribution of matter in the interior of the sun as would produce the observed effect." (2) The hypothesis of an intra-mercurial ring or group

of planetoids seems to be untenable. (3) The hypothesis of an extended mass of diffused matter like that which reflects the zodiacal light has insurmountable difficulties. (4) The hypothesis of a ring of planetoids between the orbits of Mercury and Venus is very unsatisfactory.

Newcomb finally regards Prof. Hall's hypothesis as not inadmissible. This hypothesis is a startling one, no less than that gravitation toward the sun is not exactly as the inverse square of the distance. Prof. Paul Harzer has recently published a memoir dealing with this subject, which obtained the prize of the Jablonowski Society. Harzer is disposed to attribute the greater motion of Mercury's perihelion to an irregular distribution of the sun's mass within its surface, admitted to be spherical; being denser in the parts near the solar equator. He appears to think the solar corona may have something to do with it. Harzer's theory seems to have the advantage over Newcomb's modification of Newton's law in that it leaves the latter intact.

Newcomb considers that, with the exception of the motions of the moon and of Mercury, "all the motions in the solar system, as far as known, agree perfectly with the results of the theory of gravitation. The little imperfections which still exist in the astronomical tables seem to proceed mainly from errors in the data from which the mathematicians must start in computing the motion of any planet. The time of revolution of a planet, the eccentricity of its orbit, the position of its perihelion, and its place in the orbit at a given time, can none of them be computed from the theory of gravitation, but must be derived from observations alone. If the observations were absolutely perfect, results of any degree of accuracy could be obtained from them; but the imperfections of all instruments and even of the human sight itself prevents observations from attaining the degree of precision sought after by the theoretical astronomer and make the consideration of 'errors of observation' as well as 'errors of the tables' constantly necessary."

One of the most important and interesting investigations going on now deals with the subject of variation of latitude. Certain theoretical considerations led the astronomers fifty years ago to look for changes of latitude which showed a period of 305 days. Maxwell and Bessel examined the matter and Bessel found that his latitude diminished 0″.3 in two years (1842). Other observations at various places showed aparent changes of small amounts. The results for several reasons that then appeared sound were not regarded as satisfactory, so that it was doubted by many that any measurable variation of latitude would be found. The problem assumed a new aspect, however, when Dr. Küstner, of Berlin, published the results of his observations made in 1884–85. These results showed unmistakably that a small but quite a rapid change had occurred in the latitude of Berlin, amounting to from 0″.2 to 0″.3. The examination of other observations showed similar results.

A crucial test was made by sending an expedition to the Sandwich Islands, which is 180 degrees (nearly) in longitude from Berlin. If, it was known, the latitude of Berlin increased, then a point in the northern hemisphere, 180 degrees away from Berlin, should simultaneously show a decrease in latitude, for if the pole moves toward Berlin it must move from the point on the other side of the earth. Our own government joined in the effort. Marcuse, of Berlin, and Preston, of Washington, spent more than a year on the Sandwich Islands observing for latitude, while at the same time observations were continued at Berlin, Prague and Strasburg, in Europe,

and at Bethlehem, Rockville and San Francisco, in the United States. The results of all these observations have been published and show, without a chance of error, that the earth's axis is moving, that the latitudes at the Sandwich Islands increased when the latitudes in Germany diminished and *vice versa*.

The law of the change was eagerly and industriously sought for by some of the ablest mathematical astronomers of the world. They first worked on the idea that the changes must conform to the 305-day period of Euler, combined with an annual change due to causes set forth by Sir W. Thompson. None of these investigations gave any satisfactory formulas for the prediction of the latitude of a place. In 1891 Dr. S. C. Chandler of Cambridge, Mass., began his investigations of the problem. He remarks:

"I deliberately put aside all teaching of theory, because it seemed to me high time that the facts should be examined by a purely inductive process; that the nugatory results of all attempts to detect the existence of the Eulerian period (of 305 days) probably arose from a defect in the theory itself; and that the entangled condition of the whole subject required that it should be examined afresh by processes unfettered by any preconceived notions whatever. The problem which I therefore proposed to myself was to see whether it would not be possible to lay the numerous ghosts in the shape of the various discordant, residual phenomena pertaining to determinations of aberration, parallaxes, latitudes and the like, which have heretofore flitted elusively about the astronomy of precision during the century; or to reduce them to some tangible form by some simple, consistent hypothesis. * * * It was thought that if this could be done, a study of the nature of the forces are thus indicated, by which the earth's rotation is influenced, might tend to a physical explanation of them."

Dr. Chandler examined a great mass of observations, new and old, and from their discussion has obtained a formula which at the present time expresses very well the changes of latitude at any place at any epoch. For his excellent and laborious work of several years, Dr. Chandler has received medals from our National Academy and the Royal Astronomical Society of London.

The result of Dr. Chandler's investigation show that the pole of the axis of rotation of the earth may be considered as revolving from west to east in a circle with a radius of about 14 feet, with an average period of 428.6 days. The center of this circle moves from west to east around the circumference of an ellipse in about a year. The pole of the axis of figure is at the center of this ellipse. Evidences of still greater complexity in the motion of the pole seem to be exhibited by Dr. Chandler's analysis. These motions combining make the actual path of the pole sometimes the arc of an ellipse, at times a circular arc and then again almost a straight line. At times the various changes conspire to give a maximum of ″.33, and at others the minimum separation of few hundredths of a second of the pole of rotation from the pole of figure.

During the year 1895 Chandler's formula makes the pole move nearly parallel with our meridian. This would produce observable changes of latitude here, but none at places 90 degrees east (in Europe) or west of us. To thoroughly test the formula observations must be kept up for many years at various places on the earth's surface.

The International Geodetic Association propose the establishment of four observatories on the same parallel of latitude: in Japan, Sicily, Virginia and California. At these places it is suggested that photographic observations be kept up for many years, so that more exact data can be ob-

tained for calculating, if possible, a more exact formula. No adequate theoretical explanation has been found, as yet, of the observed variations, though it is suspected that the annual part of the variation is due to meteorological causes, and that the other part may be caused by changes in the relative positions of portions of the earth's mass, such as movements of great masses of water and depositions of ice and snow.

A number of important problems are involved in this question of latitude variation. All the determinations of astronomy have been made on the assumption that our latitudes do not change. When the astronomer is supplied with sufficiently exact data the determination of various constants used in astronomy must be recalculated. Dr. Chandler and others have already begun the reinvestigation.

The problems so far discussed belong to pure astronomy. In the past forty years there has grown up, with a vigorous growth, a new branch of astronomy styled by some The New Astronomy. This branch deals with the beautiful and interesting investigations of the heavenly bodies made by the aid of that wonderful instrument of modern research, the spectroscope. On this occasion I will not trespass on your patience by attempting to describe to you the achievements of the new astronomy in the examination of the sun and the planets, the stars, nebulæ and comets. By the investigations of this young science of spectroscopy applied to the heavenly bodies, we get our first and accurate ideas of their constitution. On the spectroscopist we must depend for our knowledge of the surroundings of the sun and planets—the materials entering into the make-up of the stars, comets and nebulæ. The study of the stellar spectra brings wonderful information in regard to variable stars and the motions of stars.

The discoveries of argon and helium have unlocked some doors to knowledge previously closed tightly. On astrophysics the astronomer of the 20th century must depend for solving many problems. It is likely that a study of planetary spectra will give us the means of determining the rotation times of the planets—Venus and Mercury.

We have thus briefly and inadequately mentioned some of the problems which the astronomer of the next century must deal with. When we consider the progress made during the past twenty-years only, we are led to believe that world-wide coöperation in astronomical work will be one of the great features of the coming century. Only by such coöperation, directed by the ablest astronomers, can the most effective work be done. With such coöperation many of the troublesome problems will undoubtedly be solved.

J. K. REES.

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*A NEW FORM OF RADIATION.**

As my investigations will have to be interrupted for several weeks, I propose in the following paper to communicate a few new results.

§ 18. At the time of my first communication it was known to me that X-rays were able to discharge electrified bodies, and I suspected that it was X-rays, not the unaltered cathode rays, which got through his aluminum window, that Lenard had to do with in connection with distant electrified bodies. When I published my researches, however, I decided to wait until I could communicate unexceptionable results. Such are only obtainable when one makes the observation in a space which is not only completely protected against the electrostatic influences of the vacuum tube, leading-in wires, induction coil, etc., but which is also protected against the air coming from the

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vicinity of the discharge apparatus. To this end I made a box of soldered sheet zinc large enough to receive me and the necessary apparatus, and which, even to an opening which could be closed by a zinc door, was quite air-tight. The wall opposite the door was almost covered with lead. Near one of the discharge apparatus placed outside, the lead-covered zinc wall was provided with a slot 4 cm. wide, and the opening was then hermetically closed with a thin aluminum sheet. Through this window the X-rays could come into the observation box. I have observed the following phenomena:

(*a*) Positively or negatively electrified bodies in air are discharged when placed in the path of X-rays, and the more quickly the more powerful the rays. The intensity of the rays was estimated by their effect on a fluorescent screen or on a photographic plate. It is the same whether the electrified bodies are conductors or insulators. Up to the present I have discovered no specific difference in the behavior of different bodies with regard to the rate of discharge, and the same remark applies to the behavior of positive and negative electricity. Nevertheless, it is not impossible that small differences exist.

(*b*) If an electrical conductor is surrounded by a solid insulator, such as paraffin, instead of by air, the radiation acts as if the insulating envelope were swept by a flame connected to earth.

(*c*) If this insulating envelope is closely surrounded by a conductor connected to earth, which should like the insulator be transparent to X-rays, the radiation, with the means at my disposal, apparently no longer acts on the inner electrified conductor.

(*d*) The observations described in *a*, *b* and *c* tend to show that air traversed by X-rays possesses the property of discharging electrified bodies with which it comes in contact.

(*e*) If this be really the case, and if, further, the air retains this property for some time after the X-rays have been extinguished, it must be possible to discharge electrified bodies by such air, although the bodies themselves are not in the path of the rays.

It is possible to convince oneself in various ways that this actually happens. I will describe one arrangement, perhaps not the simplest possible. I employed a brass tube 3 cm. in diameter and 45 cm. long. A few centimeters from one end a portion of the tube was cut away and replaced by a thin sheet of aluminum. At the other end an insulated brass ball fastened to a metal rod was led into the tube through an air-tight gland. Between the ball and the closed end of the tube a side tube was soldered on, which could be placed in communication with an aspirator. When the aspirator was worked the brass ball was surrounded by air, which on its way through the tube went past the aluminum window. The distance from the window to the ball was over 20 cm. I arranged the tube in the zinc box in such a manner that the X-rays passed through the aluminum window at right angles to the axis of the tube, so that the insulated ball was beyond the reach of the rays in the shadow. The tube and the zinc box were connected together; the ball was connected to a Hankel electroscope. It was seen that a charge (positive or negative) communicated to the ball was not affected by the X-rays so long as the air in the tube was at rest, but that the charge immediately diminished considerably when the aspirator caused the air traversed by the rays to stream past the ball. If the ball by being connected to accumulators was kept at a constant potential, and if air which had been traversed by the rays was sucked through the tube, an electric current was started as if the ball had been connected with the wall of the tube by a bad conductor.

(*f*) It may be asked in what way the air loses this property communicated to it by the X-rays. Whether it loses it as time goes on, without coming into contact with other bodies, is still doubtful. It is quite certain, on the other hand, that a short disturbance of the air by a body of large surface, which need not be electrified, can render the air inoperative. If one pushes, for example, a sufficiently thick plug of cotton wool so far into the tube that the air which has been traversed by the rays must stream through the cotton wool before it reaches the ball, the charge of the ball remains unchanged when suction is commenced. If the plug is placed exactly in front of the aluminum window the result is the same as if there were no cotton wool, a proof that dust particles are not the cause of the observed discharge. Wire gauze acts in the same way as cotton wool, but the meshes must be very small and several layers must be placed one over the other if we want the air to be active. If the nets are not connected to earth, as heretofore, but connected to a constant-potential source of electricity, I have always observed what I expected; however, these investigations are not concluded.

(*g*) If the electrified bodies are placed in dry hydrogen instead of air they are equally well discharged. The discharge in hydrogen seems to me somewhat slower. This observation is not, however, very reliable, on account of the difficulty of securing equally powerful X-rays in successive experiments. The method of filling the apparatus with hydrogen precluded the possibility of the thin layer of air which clings to the surface of the bodies at the commencement playing an appreciable part in connection with the discharge.

(*h*) In highly-exhausted vessels the discharge of a body in the path of the X-rays takes place far more slowly—in one case it was, for instance, 70 times more slowly—than in the same vessels when filled with air or hydrogen at atmospheric pressure.

(*i*) Experiments on the behavior of a mixture of chlorine and hydrogen, when under the influence of the X-rays, have been commenced.

(*j*) Finally, I should like to mention that the results of the investigations on the discharging property of the X-rays, in which the influence of the surrounding gases was not taken into account, should be for the most part accepted with reserve.

§ 19. In many cases it is of advantage to put in circuit between the X-ray producer and the Ruhmkorff coil a Tesla condenser and transformer. This arrangement has the following advantages: Firstly, the discharge apparatus gets less hot, and there is less probability of its being pierced; secondly, the vacuum lasts longer, at least this was the case with my apparatus; and thirdly, the apparatus produces stronger X-rays. In apparatus which was either not sufficiently or too highly exhausted to allow the Ruhmkorff coil alone to work well, the use of a Tesla transformer was of great advantage.

The question now arises—and I may be permitted to mention it here, though I am at present not in a position to give answer to it—whether it be possible to generate X-rays by means of a continuous discharge at a constant discharge potential, or whether oscillations of the potential are invariably necessary for their production.

§ 20. In § 13 of my first communication it was stated that X-rays not only originate in glass, but also in aluminum. Continuing my researches in this direction, I have found no solid bodies incapable of generating X-rays under the influence of cathode rays. I know of no reason why liquids and gases should not behave in the same way.

Quantitative differences in the behavior of different bodies have, however, revealed

themselves. If, for example, we let the cathode rays fall on a plate, one-half consisting of a 0.3 mm. sheet of platinum and the other half of a 1 mm. sheet of aluminum, a pin-hole photograph of this double plate will show that the sheet of platinum emits a far greater number of X-rays than does the aluminum sheet, this remark applying in either case to the side upon which the cathode rays impinge. From the reverse side of the platinum, however, practically no X-rays are emitted, but from the reverse side of the aluminum a relatively large number are radiated. It is easy to construct an explanation of this observation; still it is to be recommended that before so doing we should learn a little more about the characteristics of X-rays.

It must be mentioned, however, that this fact has a practical bearing. Judging by my experience up to now, platinum is the best for generating the most powerful X-rays. I used a few weeks ago, with excellent results, a discharge apparatus in which a concave mirror of aluminum acted as cathode and a sheet of platinum as anode, the platinum being at an angle of 45 deg. to the axis of the mirror and at the center of curvature.

§ 21. The X-rays in this apparatus start from the anode. I conclude from experiments with variously-shaped apparatus that as regards the intensity of the X-rays it is a matter of indifference whether or not the spot at which these rays are generated be the anode. With a special view to researches with alternate currents from a Tesla transformer, a discharge apparatus is being made in which both electrodes are concave aluminum mirrors, their axes being at right angles; at the common center of curvature there is a 'cathode-ray catching' sheet of platinum. As to the utility of this apparatus I will report further at a later date.

W. K. RÖNTGEN.

BEHAVIOR OF SUGAR TOWARDS RÖNTGEN RAYS.

THE fact that sugar is transparent to X-rays was ascertained at an early date after Röntgen's announcement of his momentous discovery. It seemed, however, of interest to learn whether the structure of the sugar traversed by the rays might exercise any influence on the rays or modify their action on photographic plates.

Through the courtesy of Prof. M. I. Pupin, of Columbia University, who kindly extended the privileges of his laboratory to the writer, the following tests were made:

Two plates of sugar were selected. The one was a disk 16 mm. thick, sawed from a titlar; a titlar is made by pouring a magma of best white refined sugar into a cone-shaped mould, washing well with pure white sugar liquor, and then baking the mass perfectly dry and hard. This disk was, therefore, practically a solid agglomeration of pure sucrose crystals. The other disk was made by dissolving perfectly pure white sugar in water, evaporating to a certain consistency, and then casting the mass in a copper ring. This disk also measured 16 mm. in thickness; it was a perfectly clear and transparent solid of a yellow color, and consisted of amorphous sugar-candy—so-called barley sugar.

A few preliminary trials were made by photographing with X-rays through these plates of sugar—with and without fluorescent screens—varying the time of exposure, etc. Finally, the following experiment was carried out.

A photographic plate was placed in a box, on the outside of which six metal disks were arranged in two groups of three each. Each group consisted of a medal of aluminium, provided with figures and inscriptions in bas-relief, a plain disk of aluminium and a silver quarter dollar.

One of these groups was covered with the crystalline, the other with the amorphous

sugar plate. The Crookes tube was suspended $6\frac{1}{4}$ inches above the plates and an exposure of forty minutes was given.

The conditions under which the two sugar plates were placed were therefore identical and the results obtained comparable. On developing the photographic plate it was found that both sugar plates had permitted the X-rays to pass through sufficiently freely to form clear and well defined pictures of the metallic disks.

The figures and inscriptions on the aluminium medals were discernible in both instances, and the outlines of both the aluminium disks and of the silver coins were also well marked.

The negative, however, showed unmistakably that the amorphous sugar is more transparent to the X-rays than the crystalline modification. In the former case the background proved to have an even and darker hue, showing that X-rays had passed through freely and evenly. In the latter case the background was less dark and of a rather mottled appearance, in some places exhibiting apparently a faint outline tracing of the crystalline structure beneath which it had rested. This fact may be of interest in view of the mooted question concerning the power of diffusion and refraction of the X-rays.

In this connection it may not be amiss to also refer, briefly, to some tests made to ascertain whether or no the X-rays exercise any influence on polarized light. To this end a tube was made of aluminium, 200 mm. in length and 31 mm. in diameter; the walls were 2 mm. thick. This tube was filled successively with solutions of sucrose, dextrose, levulose and raffinose.

This tube with its contents was placed in a sugar polariscope ; a ray of light was permitted to pass through the tube and the deviation of the polarized light produced by the solutions was noted. The polariscope with the filled tube was then placed underneath a Crookes tube in such a manner that the tube was directly in the path of maximum intensity of the X-rays, *i. e.*, in the path of the cathode rays, so that the rays would pass through the tube practically at right angles to the beam of polarized light which traversed the tube longitudinally.

The times of exposure given varied; seven minutes for the sucrose solution, ten minutes for the levulose and the raffinose solution and fifteen minutes for the dextrose solution, but in no instance was any deviation of the ray of polarized light noticeable. The polarization of the solutions were :

Sucrose,	+49.9
Raffinose,	+15.3
Dextrose,	+ 7.2
Levulose,	— 8.8

Of course these tests alone are not sufficient in number or kind to permit the drawing of any conclusive inference as to whether the X-rays influence the plane of polarized light or not, but they do establish the fact that, under the conditions under which these tests were made, no such influence was exerted. FERDINAND G. WIECHMANN.

THE X-RAYS IN MEDICINE AND SURGERY.

ON April 22d I succeeded in applying the X-rays to the diagnosis of disease in such a manner as to make it seem that a very wide field was open to medical as well as to surgical investigations by means of the X-ray.

Using a 'focussing' tube powerfully driven, I found it quite possible to cause calcium tungstate to fluoresce, even though a human trunk or head be interposed between the tube and the fluorescing screen.

Further, it became evident that the backbone, the ribs, the bones of the members, and the outline of the skull and of the upper portion, at least, of the pelvis could be

plainly seen as shadows on the screen. The cartilaginous laminæ between the vertebræ could be distinguished. The heart could be seen in faint outline, being slightly more opaque than the lungs, which are very transparent. The liver is very opaque, and its rise and fall as the patient under examination breathed was very easily seen.

I was able to make a diagnosis of cases of tuberculosis, pneumonia, enlarged heart and enlarged spleen without difficulty. The outline of the heart was indicated by me and by Mr. Lawrence, who is working with me almost exactly as it had been mapped out by percussion, our greatest disagreement being about one-half an inch, the diameter of the heart being seven inches. An examination of some five seconds convinced us that a tuberculous patient was at least fairly sound on one side and very bad on the other, and this again agreed with the previous diagnosis at the hospital of which we, of course, were ignorant. The enlarged spleen could be outlined with great clearnesss, it being rather transparent, while the abdomen is ordinarily quite opaque.

A boy of three years, convalescent after an attack of pneumonia, was found to be transparent in that part of the lungs which had been diagnosed as 'clear,' and opaque in those portions which were shown by percussion to be still more or less filled up.

A buckle or a small pellet of lead is easily detected through any part of the body, except the lower part of the abdomen, and buttons and hooks and eyes are easily seen through the more transparent parts.

A patient was brought to us whose arm had been broken by a musket ball, and the exact location of the bullet was desired. After an examination of not more than a minute the bullet could be plainly seen. It had broken the ulna and then imbedded itself on the inner side of the radius about three inches nearer the shoulder. We marked the location of the bullet in two planes, and when the surgeons made an incision it was found that we were not in error by more than an eighth of an inch.

We have taken photographs by means of a Thomson high frequency coil in one-fifth of a second, as it seemed to be desirable to be able to work very rapidly to get photographs of such objects as do not remain fixed in position for any length of time.

The skull is not opaque, and the thicker and thinner positions can be distinguished, but of course no notion can be obtained of the texture of the brain. The detail of the lower jaw, its joint, the teeth, the filling in the teeth, and so on, can be clearly made out. The æsophagus is very transparent, and a foreign metallic body could hardly fail of detection unless well down in the lower part. The cartilaginous rings in the trachea, the glottis and epiglottis can be seen in fair outlines. Younger persons are more transparent than older, but show less differentiation, even the bones being quite transparent in a boy of ten. The brilliancy of the tube is increased many times by grounding the cathode.

CHAS. L. NORTON.

MASS. INSTITUTE OF TECHNOLOGY.

CURRENT NOTES ON PHYSIOGRAPHY.

DE LAPPARENT'S LEÇONS DE GÉOGRAPHIE PHYSIQUE.

THERE is no European text-book that has so fully caught what has come to be called the American method in physical geography or geomorphology, as de Lapparent's *Leçons de géographie physique* (Paris, Masson, 1896, 590 p.). Omitting other divisions of the subject, the whole volume is devoted to the physiography of the land. The work of denuding forces, acting on various initial land forms produced by uplift, deformation, volcanic accumulation or otherwise, is deliberately followed through the geographical cycle to its close in a peneplain of faint relief. Modifications of the general scheme of geographical devel-

opment, due to movements with respect to baselevel, to glacial action, to wind action, and to subterranean waters, are considered in succession. These systematic chapters are followed by others in which an excellent outline of the physiography of Europe is presented, with briefer treatment of the other parts of the world. American readers who desire to cite European physiographic examples will find this book very helpful. It is illustrated with many diagrams and a good number of maps and views; its detailed table of contents hardly compensates for the absence of an index.

THE INTERIOR PLATEAU OF BRITISH COLUMBIA.

A RECENT report by Dr. G. M. Dawson on the area of the Kamloops map sheet in the interior of Columbia (Geol. Surv. Canada, Ann. Rept. vii., 1896) treats in more detail a portion of the region that the same author has previously described (Physiogr. Geol. of the Rocky Mountain region in Canada, Trans. Roy. Soc. Can., iii., 1890). Considered in a broad way, and in contrast to the mountains by which it is bordered, the interior region may be regarded as a plateau. Although deeply trenched by numerous valleys of late Pliocene date, these are lost to view when standing on the uplands, whose profiles run together to form a nearly horizontal sky line. The plateau is explained as a peneplain of subaërial denudation. It is enclosed on the west by the Coast range (not to be confused with the Coast range or the Cascade mountains of our Pacific slope), whose summits reach remarkably uniform altitudes of about 8,000 or 9,000 feet. This equality is explained as the result of the rapid consumption of any summits that may have formerly risen into greater altitudes, on the assumption that the progress of denudation in the partially snow-covered zone is several or many times greater than below it. This appears to be an interesting example of Penck's 'Oberes Denudationsniveau' (Morphologie der Erdoberfläche, ii., 164). A pronounced 'rain shadow' and chinook belt occur on the plateau district in the lee of these mountains. Interesting details are given concerning glacial action, lake basins, alluvial fans and terraces, and other features.

THE VOLCANIC GROUP OF TOPOGRAPHIC FORMS.

THE chapter devoted to volcancos in most physical geographies is chiefly concerned with volcanic cones, so young as to be little worn. The more thorough study and classification of geographical forms, as primarily determined by structures and secondarily modified by sculpture, greatly extends the list of features associated with volcanic action, even including the products of those abortive attempts at eruption which have been blindly satisfied before reaching the surface. The buttes formed when these 'plutonic plugs' are revealed by denudation occur in fine variety of development and expression in the region of the Black hills of Dakota, and are described in the current number of the (Chicago) *Journal of Geology*, by Russell, with his customary appreciation of physiographic relations. A number of excellent photographs are reproduced as illustrations. The series of forms begins with Little Sun Dance dome, an arch of limestone, stripped of a great thickness of overlying weaker strata, but unbroken, even uncracked; the igneous rock not yet revealed. Mato Teepee, Inyan Kara and other imposing buttes are fully revealed plugs. The surrounding rims of harder stratified rocks offer interesting examples of outer slope and inface,* with inner subsequent valleys, all in concentric circular arrangement. One of the illustrations is a view looking outward

* The invention of this excellent term, the abbreviation of 'inward facing escarpment,' should be credited to Mr. L. C. Glenn, of Darlington, S. C.

along a radial consequent valley through a notch in a limestone rim.

LE TOUR DU MONDE.

THE illustrated weekly, published by Hachette & Co., Paris, under the above title supplies so many excellent illustrations well reproduced from photographs taken in various parts of the world, that it deserves mention as a contributor to physiographic knowledge. The volume for 1895 contains, among many others, a number of admirable pictures from the inner Sahara, portraying the escarpments, dunes and wadies with remarkable effect of glaring sunlight; of the lakes of Bavaria, both within and without the Alps; of tropical and polar scenes. The text is generally narrative and descriptive, with much about peoples and their customs, entertaining rather than strictly scientific; and some of the pictures bear evidence of touching up or even of invention by the too facile hand of the Parisian artist; but the volume as a whole is as instructive as it is attractive.

THUNDER STORMS AT SEA ARE NOCTURNAL.

THE greater frequency of thunder storms in the winter and at night around the coast of Scotland has been shown by Buchan. When thunder storms occur in New England in winter they are generally observed along the coast and after nightfall, as has been shown by records of the New England Meteorological Society. Now Meinardus, of the *Deutsche Seewarte* at Hamburg, finds even the thunder storms of the Bay of Bengal to have a distinct nocturnal maximum (Annalen der Hydrog., 1895, 506–511). It has been suggested by Grossmann and others that the cause of this contrast with thunder storms on land probably arises from the dependence of the maritime storms on instability produced by radiation and cooling of the upper surface of cloud sheets, which proceeds best at night, especially in winter nights; while local storms on the land arise from the overheating of lower layers of air close to the hot ground, and this condition has its maximum on summer afternoons.

CURRENT NOTES ON ANTHROPOLOGY.

THE ANTHROPOLOGICAL INSTITUTE OF GREAT BRITAIN.

ON January 21st this institution held its annual meeting, when its President, Mr. E. W. Brabrook, delivered the address of the occasion, reviewing the work of the body during the past year. It presents an encouraging list of papers on the leading branches of anthropologic study, and notes the advancements which have been made in the popularity of this department of learning. The establishment of a professorship of anthropology at Oxford proves that that famous University is no longer the house of refuge for effete ideas, as was once charged against it. The speaker referred to the Galley Hill skeleton (see SCIENCE, 1896, Jan. 17), and from a close personal inspection of it declares that "the balance of probability lies in favor of its authenticity." He adds some strong words on the unity of the anthropologic sciences, refuting the narrow views of Topinard, who, in direct conflict with his great teacher, Broca, would confine it to the study of physical types.

The address is one which will foster and develop the study of man in its true sense.

CANADIAN ARCHÆOLOGY.

A VALUABLE archæological report, prepared by Mr. David Boyle, appears as an Appendix to the Report of the Minister of Education, of Canada (also printed separately). It covers 79 pages, a number of which are devoted to the exposition of 'primitive industries and working methods.' Several earthworks in the province of Ontario are described, with illustrative plans and surveys. Some rock paintings are mentioned, especially one at Lake Mas-

sanog, the figures from which are reproduced, and the suggestion advanced that they indicate Huron-Iroquois influence. A number of pipes of clay and stone and arrow heads of unusual shape are figured. The timely warning is given that of late years the manufacture of fraudulent specimens of this character has notably increased, and collectors should be on the alert. To detect these 'fakes,' Mr. Boyle recommends the use of a lens of low power by which it is easy to distinguish where the partination has been destroyed.

D. G. BRINTON.

UNIVERSITY OF PENNSYLVANIA.

SCIENTIFIC NOTES AND NEWS.

BATRACHIANS AND CRUSTACEANS FROM THE SUBTERRANEAN WATERS OF TEXAS.

IN advanced sheets from the Proceedings of the U. S. National Museum, Dr. Leonard Stejneger describes a new genus of batrachians from an artesian well at San Marcos, Texas, and Mr. James E. Benedict describes a new genus and three new species of crustaceans from the same well. Dr. Stejneger gives some interesting details regarding the new species of salamander-like batrachians which he calls *Typhlomolge Rathbuni*. "The animals, by their want of external eyes and their white color, at once proclaimed themselves as cave-dwellers, but their extraordinary proportions, absolutely unique in the order to which they belong, suggest unusual conditions of life, which alone can have produced such profound differences. The most startling external feature is the length and slenderness of the legs, like which there is nothing among the tailed batrachians thus far known. While the normal number of fingers and toes is present (4 and 5), it is worthy of note that not only is there a great variation in the relative length of these members, but even the length of the legs in the same animal may differ as much as two millimeters. Viewed in connection with the well-developed, finned swimming tail, it can be safely assumed that these extraordinarily slender and elongated legs are not used for locomotion, and the conviction is irresistible that in the inky darkness of the subterranean waters they serve the animal as feelers, their development being thus parallel to the excessive elongation of the antennæ of the crustaceans, of which I have been informed by Mr. Benedict. The external gills at once suggested that these animals might be only larvæ. The fact that one of them contained large eggs, and that another expelled three eggs after being caught, was no positive proof to the contrary, but in conjunction with the affinity of the species to other forms known to have persistent gills throughout life it makes it absolutely certain that we have to do with an adult and final animal."

THE FOREST RESOURCES OF THE UNITED STATES.

IN a recent circular prepared by Dr. B. E. Fernow for the Division of Forestry of the U. S. Department of Agriculture it is stated that the forest area of the United States (exclusive of Alaska) may be placed at somewhat less than 500,000,000 acres. This does not include much brush and waste land which is, and will remain for a long time, without any economic value. This area is very unevenly distributed; seven-tenths are found on the Atlantic side of the continent, only one-tenth on the Pacific coast, another tenth on the Rocky Mountains, the balance being scattered over the interior of the Western States. Both the New England States and the Southern States have still 50 per cent. of their area, more or less, under forest cover, but in the former the merchantable timber has been largely removed. The prairie States, with an area in round numbers of 400,000 square miles, contain hardly 4 per cent. of forest growth, and the 1,330,000 square miles—more than one-third of the whole country—of arid or semi-arid character in the interior contain practically no forest growth, economically speaking. The annual value of forest products is estimated at over $1,000,000,000, which makes the industry next in importance to agriculture, exceeding in the value of its products the mining industries by more than 50 per cent.

CAPE COLONY GEOLOGICAL COMMISSION.

WE have already announced the appointment, by the government of Cape Colony, of a Geo-

logical Commission, which is to report to the Secretary for Agriculture. *Natural Science* in its May number states that: "The Commission has now appointed the following gentlemen to begin the work of surveying and mapping the country: Geologist, G. S. Corstorphine, B.Sc. (Edin.), Ph.D. (Munich); Assistant Geologists, A. W. Rogers, B.A. (Cantab.), and E. H. L. Schwarz, A.R.C.S. The Commission also intends to publish in June a bibliography of South African geology, which has been compiled by Mr. Harry Saunders, the Secretary to the Commission. During the last ten years some £35,000 has been spent by the government of Cape Colony for geological purposes; but complaints have been made that, although science may have been advanced by the contribution of a scattered paper or two to English publications, or by the enrichment of the British Museum with a skeleton of *Pareiasaurus*, still the Colony itself has nothing tangible to show. For the present Commission an appropriation of £1,500 has been made for the months of December, 1895—June, 1896. It is hoped that the future work of the Commission will be carried on by annual grants of £2,000. Although South Africa abounds in mining engineers, prospectors and such-like practical geologists, of more or less competence, still not much advance in our purely scientific knowledge of its geology has been made since the days of A. G. Bain. The Commission intends to devote its energies purely to the scientific aspects of the science and to steer as clear as possible of the ordinary speculator. By this means a secure foundation will be laid for the geology of Cape Colony. The Commission will be glad to receive copies of any geological publications, in return for which they offer to forward the reports on the geology of the Colony."

THE METRIC SYSTEM.

AT the business meeting, held April 18, 1896, the Engineers' Club of Philadelphia discussed certain preambles and resolution in regard to the Metric System.

After a full debate it was decided that a letter ballot be taken on the following preambles and resolution:

WHEREAS, The adoption of an international system of weights and measures is a subject of great practical importance, and

WHEREAS, The Metric System is the most convenient general system now in use, and its continued extension indicates that it is the only existing system of weights and measures that bears a promise of universal adoption, and

WHEREAS, It is believed that the difficulties in the way of its adoption are far more than compensated by the advantages to be gained by its use, and

WHEREAS, The question of the establishment of the Metric System is now under consideration by Congress; therefore be it

Resolved, That the Engineers' Club of Philadelphia respectfully urges its Representatives at Washington to advocate the adoption of the Metric System as the only legal standard in the United States, and to promote such international coöperation as will provide unity of practice amongst commercial nations.

The result of this letter ballot has just been announced and shows 100 to 60 in favor of the preambles and resolution.

GENERAL.

THE second annual meeting of the Botanical Society of America will be held in Buffalo, N. Y., on Friday and Saturday, August 21 and 22, 1896. The Council will meet at 1:30 p. m. on Friday, and the Society will be called to order at 3 p. m. by the retiring President, Dr. William Trelease, Director of the Missouri Botanical Garden. The President-elect, Dr. Charles E. Bessey, professor of botany in the University of Nebraska, will then take the chair. The afternoon session will be devoted to business. At the evening session the retiring President will deliver a public address on 'Botanical Opportunity.' The sessions for the reading of papers will be held on Saturday at 10 a. m. and 2 p. m. The Botanical Society of America is affiliated with the American Association for the Advance of Science, whose sessions this year begin on Monday, August 24th, in Buffalo.

THE dissolution of the New England Meteorological Society was decided upon at a meeting held April 25th in Boston. The various undertakings of the Society have either been transferred to other organizations or discontinued

on account of the diversion of the interests of several of the more active members into other channels. The recent cessation of the *American Meteorological Journal* was finally the determining step in the disbanding of the Society.

MME. AUDIFFRED has given the French Academy of Sciences the sum of 800,000 fr., the interest of which will be awarded, without regard to nationality, for the discovery of a cure for consumption.

M. A. RENIER has bequeathed 2,000,000 fr. for the establishment of a physiological laboratory in Brussels.

THE *Scientific American*, which for fifty years has been an important factor in the diffusion and advancement of technical and general science, will publish an anniversary number on July 25th. It offers a prize of $250 for the best essay, not exceeding 2,500 words in length, on 'The Progress of Invention During the Past Fifty Years,' which will be published in the anniversary number.

THE issue of *Nature* for May 7th will contain a photogravure of Sir Joseph Lister, President of the Royal Society, accompanied by a biographical sketch and an appreciation by Prof. Tillmanns, of Leipzig.

MESSRS. PERSIFOR FRAZER, Angelo Heilprin, Benjamin Smith Lyman and Theodore D. Rand have been appointed by the Academy of Natural Sciences of Philadelphia as the Committee on the Hayden Memorial Geological Award for 1896.

A NEW and thoroughly revised edition of Lyell's Student's Elements of Geology is about to be published by Murray. The work has been carefully revised by Prof. J. W. Judd, Dean of the Royal College and a former pupil of Lyell's.

A SPECIAL despatch to the New York *Evening Post* from New Haven states that on January 13, 1893, John E. Lewis, of Ansonia, while photographing Holmes' comet through a telescope, caught upon the plate the path of a large meteor showing its place among certain stars. Prof. H. A. Newton, of Yale, made a very careful computation showing that the meteorite probably fell at a place about two miles north of Danbury, Conn., near Kohanza reservoir. Prof. Newton has now received intelligence of the finding of a meteorite at almost exactly the computed point. It is described as an oval specimen, fifteen and a-half inches long, and seven and a-half inches in diameter, weighing twenty-six pounds.

THE New York *Medical Record* states that an offer has been made by an inventor to the municipality of the city of Paris to sterilize five thousand cubic meters daily of water for public consumption at his own expense. After preliminary inquiry the municipality has decided to obtain an expert report upon the value of the proposed measure, and if it is found to be of practical utility the inventor's offer will be accepted as a preliminary to adopting the system in case the experiment is satisfactory.

Nature states that the annual general meeting of the British Ornithologists' Union was held at 3 Hanover Square on April 22d. In the absence of Lord Lilford, the President, Mr. P. L. Sclater, F.R.S., took the chair. The report of the Committee stated that *The Ibis* (the journal of the Society) had been regularly published during the preceding year, and that the Union consisted of 269 ordinary members, besides honorary and foreign members. Twenty-nine new ordinary members and one new foreign member were proposed and elected. Mr. Sclater brought forward a scheme for a new synopsis of the described species of birds, to be arranged in six volumes, corresponding with the six zoölogical regions of the earth's surface. This was referred to a committee to report upon.

VOLUME I., of the University Geological Survey of Kansas, by Prof. Erasmus Haworth and assistants, is now ready for distribution and may be had free by recipient paying transportation, which is twenty-two cents if sent by mail. All applications should be sent to Chancellor F. H. Snow, University of Kansas, Lawrence, Kansas.

DR. GEORGE A. DORSEY, who has been an instructor at the Peabody Museum during the last five years, has accepted a call to the Field Columbian Museum of Chicago, to take the position of curator in the department of anthro-

pology. Mr. Frank Russell, of the graduate school, has been appointed assistant in anthropology to take Dr. Dorsey's place as instructor in the preliminary anthropological courses next year.

THE State Fair Association of Rhode Island offers $5,000 in prizes for the exhibition and competition of horseless carriages at the State Fair, Narragansett Park, in September.

THE Committee of the Massachusetts Legislature has reported in favor of an appropriation of $100,000 to be used for the extermination of the gypsy moth. The Committee recommends that one or two entomologists be sent abroad to study the habits of the gypsy moth with a view to introducing, if possible, some parasite to prey upon the insect.

ANDREW S. FULLER, a writer on agricultural and botanical subjects, died on May 4th, at his home at Ridgewood, N. J., age 88 years. The death is also announced of Alfred Debains, professor at the agricultural college at Rennes.

PROF. ANGELO HEILPRIN has been appointed to represent the Academy of Natural Sciences of Philadelphia at the Mining and Geological Millennial Congress to be held at Budapest, September 25th and 26th, in connection with the celebration of the founding of the Kingdom of Hungary.

MR. GILBERT BOWICK has purchased for the British Antarctic Expedition, which leaves England in September, the survivors of the pack of dogs acquired by Lieut. Peary from the Esquimaux of North Greenland. They will be brought from Christiania and placed for the present in the London Zoölogical Garden.

AT a meeting of the Royal Geographical Society on April 27th the President announced that the annual honors had been awarded by the Council as follows: The Founders' Medal to Sir William Macgregor, K.C.M.G., for the valuable geographical work he has done in New Guinea during the years that he has acted as Administrator and Lieutenant-Governor; the Patrons' Medal to Mr. St. George R. Littledale for his important expeditions in the Pamirs and Central Asia; the Murchison award has been given to Khan Bahadur Yusuf Sharif, native Indian surveyor; the Gill memorial to Mr. A. P. Low, of the Canadian Survey, for his explorations in Labrador; the Black grant to Mr. J. Burr Tyrrell for his expeditions to the Barren Grounds of northwest Canada; and the Cuthbert Peek grant to Mr. Alfred Sharpe for his many journeys in British Central Africa. The following geographers have been made honorary corresponding members of the Society: M. de Semenoff, Vice-President of the Russian Geographical Society; Dr. Von den Steinen, President of the Berlin Geographical Society; Dr. G. Neumayer, Director of the Naval Observatory, Hamburg; M. de Lapparent, President of Council of the Paris Geographical Society; Dr. Albrecht Penck, Professor of Geography, Vienna University; Dr. Otto Petterson, the Swedish oceanographer; Dr. Kan, President of the Dutch Geographical Society; Prof. H. Pittier, Director of the National Physico-Geographical Institute of Costa Rica.

STILL another welcome contribution to our knowledge of the changes of plumage in birds is a paper by Witmer Stone entitled *The Molting of Birds with Special Reference to the Plumages of the Smaller Land Birds of Eastern North America.* This appears as a separate from the Proceedings of the Natural Sciences of Philadelphia and discusses in more or less detail the molt of some 130 species. A captious critic might, perhaps, complain that in some cases the conclusions were based on an examination of rather a small number of specimens, but only one who has undertaken similar investigations can appreciate the difficulty of obtaining proper material and the labor involved in its study. There is an introductory chapter treating of molt in general, in which Mr. Stone briefly discusses the question of direct change in the color of feathers and states that he cannot admit that we have any proof of an actual change of color in a feather apart from what may be produced from abrasion or bleaching. The author, by independent investigation, reaches the same conclusion as Mr. Chapman in regard to the change of color in the Dunlin and Snowflake. There has been abundant *testimony* to change of color in feathers without molt, and it is now in order for some one to produce a little evidence.

Two interesting additions to the alums have

been recently made by Piccini and are described in the *Gazetta Chimica*. By the reduction of a sulfuric acid solution of vanadium dioxid in the electrolytic cell in the presence of an alkali-sulfate an alum is formed. The ammonium vanadium alum is very soluble, those of rubidium and cesium much less so. By a similar reaction Piccini has obtained the cesium titanium alum, the first of the titanium sulfates to be formed. These salts are the first representatives of the alums among the elements of the fourth and fifth groups of the periodic system.

THE question as to the fusibility of platinum in a carbon heated furnace seems at least to have been definitely settled by Victor Meyer. A sheet of platinum completely enclosed in a mass of fire clay was fused to a globule in a blast furnace heated with gas carbon. In this case action of carbon or of furnace gases on the platinum was absolutely excluded. Under similar conditions an alloy of platinum with 25% iridium was unchanged.

IN the *Contemporary Review* for May, Dr. Alfred B. Wallace describes M. Elisée Reclus' proposed gigantic model of the earth, already noticed in this JOURNAL and argues that the construction of such a globe would be feasibile and desirable. But he thinks that the scale proposed by M. Reclus, $\frac{1}{100000}$ should be reduced by one-half. This would give an internal diameter of 167 feet, and a scale of almost exactly a quarter of an inch to a mile. The chief point made by Dr. Wallace is, however, that the model should be placed on the inner surface of the sphere.

ACCORDING to *Nature*, on July 2d the Second International Congress of Applied Chemistry will open in Paris. In addition to strictly technical questions, the Congress will discuss the analytical processes needed for the guidance of manufacturers and the benefit of the consumer. The proceedings will be conducted in ten sections, and, judging from the number and interest of the questions which will be brought up in each, there will be no lack of work. The sections represent such diverse subjects as chemical products, electro-chemistry, coloring matters and dyeing, pharmaceutical products, metallurgy and mining, surgar-refining, vintnery, brewing, distilling, agricultural chemistry, photography, alimentation and milk supply. The 'Association des Chemistes de Sucerie et de Distillerie,' which is organizing the Congress, has formed a committee, comprising several members of the French Government, a large number of members of the Institute, and many of the foremost men in science and industry in France. Further information with reference to the Congress can be obtained from M. Dupont, 156 boulevard Magenta, Paris.

UNIVERSITY AND EDUCATIONAL NEWS.

MRS. STANFORD has transferred to the trustees of Stanford University $2,500,000, the amount of the bequest left by the late Senator Stanford.

MR. JOHN D. ROCKEFELLER has agreed to give Vassar College $100,000 toward the erection of a new dormitory or a recitation hall.

AT a meeting of the trustees of Columbia University, on May 4th, Mr. E. A. MacDowell was appointed Professor of Music, and Dr. Franz Boas lecturer on physical anthropology. The name of the present faculty of the School of Mines was changed to that of the Faculty of Applied Science, which will be intrusted with the care of the School of Mines, the School of Chemistry, the School of Engineering and the School of Architecture. The building for the Department of Chemistry, to be erected as a memorial to the late Frederick Christian Havemeyer at a cost of about $450,000, by his sons and daughters, F. C., Theodore A., Thomas J., and Henry O. Havemeyer, Mrs. Katherine B. Belloni and Mrs. L. J. Louisa Jackson, and by his nephew, Charles H. Senff, was formally accepted by the trustees.

THE sum of $100,000 has been given by friends of Barnard College to pay the mortgage on the grounds, and secure the gift of $100,000 for building purposes pledged on condition that the mortgage should be paid by May 9th.

THE summer school of Union College will hold a session of six weeks at Saratoga, from July 6th to August 14th. Thirty courses are offered. The ninth annual session of the Wisconsin summer school will be held at the University for six weeks, from July 6th to August 14th,

1896. Thirty-seven courses of instruction will be offered in fourteen departments.

THE announcement is issued of the Fifth Annual Summer School at the University of Minnesota for the four weeks between July 27th and August 21st. The school is organized in two sections: University and Elementary. The University section offers 19 courses, of which 10 are in the Sciences, as follows :

Botany, Prof. MacMillan,	2 Courses.
Chemistry, Prof. Frankforter,	2 Courses.
Physics, Prof. Jones,	2 Courses.
Physiography, Mr. Goode,	2 Courses.
Physiology, Prof. Nachtrieb,	1 Course.
Physiological Psychology, Mr. Gale,	1 Course.

Special courses of lectures will be delivered daily. Four Educational Congresses will hold sessions during the month, viz.: Institute instructors; State Normal School officers; City Superintendents, and the Society for Child Study. The School is authorized under the anthority and supervision of the State Department of Public Instruction. Tuition is free.

PROF. HAROLD B. SMITH, at present professor of electrical engineering in the Purdue University, Lafayette, Ind., has been elected to a new chair of electrical engineering, established in the Worcester Polytechnic Institute.

AMERICAN students going abroad for the summer may be interested to know that there will be held at Jena, from the 3d to the 15th of August, a *Ferienkurse*, including lectures on astronomy, botany, physics, zoölogy, hygiene, physiology, psychology, philosophy, pedagogy, modern languages, literature and history.

A COURSE of lectures on colonial botany is offered during the present summer semester at the Botanical Garden and Museum of Berlin, by Profs. Engler, Schumann, Volkens and Urban, and Drs. Warburg, Gilg, Lindau, Perring, Dammer and Gürke. The course occupies two hours per week and is given without charge.

WE learn from the *Academische Rundschau* that a regulation has been issued allowing women to attend lectures at the University of Berlin after securing permission from the Minister of Public Instruction and the instructor. The University of Munich has given one woman permission 'experimentally' to attend courses in geology and paleontology. Special courses for women, which include botany, physics and chemistry, have been arranged at the University of Göttingen.

THE sum of 460,000 Marks has been appropriated by the government for the construction of a library building for the University of Freiburg.

DISCUSSION AND CORRESPONDENCE.

PRINCIPLES OF MARINE ZOÖGEOGRAPHY.

PROF. THEO. GILL* has given a very interesting comparison of his own views of zoögeographical division of the earth's surface, especially of the oceans, and those set forth by myself in my 'Grundzüge der Marinen Tiergeographie.' This comparison is the more interesting since we agree in many points with each other. Nevertheless, there are some differences which, as Prof. Gill very properly states, are chiefly due to the different starting points. The discussion is consequently directed at once in a particular direction, and upon this I wish to lay the greatest stress: namely, upon the difference between my method of investigation and that generally employed hitherto. While the method of Prof. Gill, and of almost all the other students of zoögeography, is an inductive one, *i. e.*, constructing zoögeographical divisions according to the actual distribution of animals, I make use of the deductive method, considering merely the physical laws that govern the distribution of animals. In what follows I shall state briefly the reasons which have induced me to urge a change in the method of zoögeographical research.

1. Our knowledge of the actual distribution of marine animals is extremely incomplete; we do not know the exact limits of the range of *most* of the species, so that it is impossible at present to get a correct idea of the general features of their distribution, and of the assemblage of the different forms of animals in any particular locality.

2. We cannot derive any divisional limitations of general value from a particular group

*Science N. S. III., No. 66, April 3, 1896, p. 514–516.

of animals, since each group is subject to different laws. Thus a division obtained by the study of the prevailing conditions in one group is often exactly the opposite of that found to prevail in other groups. From this disagreement arose the continuous dispute between different writers with regard to the number and the limits of the zoögeographical divisions, each wishing to transfer the results obtained in his favorite group to other groups.

3. The actual distribution of animals is the result of development during the course of the geological history of the earth. While many animals show a distribution which corresponds to the physical conditions of recent times, many others point clearly to conditions of former periods, and their distribution is only intelligible under the supposition that formerly different conditions prevailed on the earth.

Thus we should expect that investigations founded on the actual distribution of animals are in the first place incomplete, and in the second the results obtained are contradictory in many cases. In order to overcome the latter difficulty, statistical lists of the distribution of these animals have been prepared showing which distributional features are most common. But I object even to these statistics. My first reason shows clearly that such statistics never are complete, and it is very dangerous in science to rely upon statistics deficient in the main quality by means of which they are useful at all.

From these considerations I am induced to use the deductive method, and to construct zoögeographical divisions according to the differences in the physical conditions influencing the distribution of animals. But I remark expressly, I do not regard such a division of the earth as the final aim that should be reached in zoögeography, but only as a means which facilitates zoögeographical study. My divisions represent only *a rough sketch of the distribution of the different conditions of life in recent time.* Of course, these divisions do not agree with those assigned to animals the range of which is due to conditions belonging to former times; but even in such cases my divisions have a decided advantage. If there are any exceptions in the actual distribution of certain forms we see at once that these animals do not follow the general rules according to which the divisions are conceived, and the knowledge that certain laws do *not* control particular cases is a considerable advantage in revealing the true causes of these peculiarities. For the whole point or aim of zoögeographical research is to find out the *causes of the distribution* of each animal form.

The above reasons, I think, are sufficient to demonstrate that my starting point has certain advantages over that of other students in zoögeography. Notwithstanding the results of my investigations are very similar to these obtained by Prof. Gill. This is due, I believe, to the extensive and correct character of his preliminary work, to the exact and fundamental study of the actual distribution of certain groups of animals, and to the full use he has made of the known facts. On the other hand, I think, Prof. Gill's method is not so fundamentally different from mine as it seems to be perhaps according to his own statement. It is true he 'prefers the inductive method' (p. 515), and his divisions are adapted in some degree to the actual distribution of certain animals; nevertheless his chief marine divisions are conceived according to a *physical* principle, to the *temperature* of the ocean waters, a principle which was first introduced by Dana, and the importance of which is recognized by Prof. Gill in the concise sentence: "Temperature is a prime factor, and land a secondary, in the distribution of marine animals."* On this point our opinions agree completely, and thus, I think, our starting points are not so extremely different, since Prof. Gill in constructing his zoögeographical divisions of the seas pays due attention to temperature, which is at least one, and indeed the most important, physical factor.

With regard to the objections of Prof. Gill to my life districts, I should like to add here that I do not fully understand why he says they are misconceived, since they are framed in contravention of my own principle of continuity. If all the life districts were continuous, any further divisions would be impossible and needless, as is the case in the abyssal (bassalian) district, and even the discontinuity of the others obliges

*Presidential Address Biol. Soc. Washington, Jan. 19, 1883, p. 39.

us to make further divisions so as finally to reach continuous and consistent areal units. I formed my division into life districts according to the primary conditions of life, and I never claimed that all the localities on the earth showing the same primary conditions of life should be continuous; I only claimed that the smallest areal units of zoögeographical division should be continuous. Different conditions of life have existed since the beginning of the geological history of the earth; the secondary divisions into regions of the marine life districts, which were formerly continuous in a greater or less degree, are made according to the topographical continuity, which was interrupted by the introduction of climatic differences in much later times. The assigned districts of life are old, and during a long time they were the only zoögeographical divisions of the seas. The different regions of the life districts are of a comparatively recent date, and their existence did not begin until a differentiation of climate took place.

Prof. Gill further suggests that the life districts themselves are of unequal value, and they should be seggregated into two primary categories, marine and inland. I agree perfectly with this view, as the same view is maintained in my book, the title of which reads: 'Principles of *marine* zoögeography,' thus leaving out of view the consideration of *inland* districts. Further, I expressly state (p. 18–20) that the diagnostic value of my five life districts differs, for if we were to establish a perfectly philosophical division we should have to introduce other districts, but only the five named are of *practical* value. The fact that the marine life districts are unequal as regards the number of subdivisions I cannot consider as an objection to their correctness. Indeed, in this respect they *are* unequal, but if they are unequal in nature why should we try to correct nature in proposing a scheme on paper in which the divisions would appear more equal than they really are?

I am glad that Prof. Gill by his remarks has given me an occasion to state again in a concise form my reasons for neglecting the inductive or statistical method in zoögeography. I think that practical results favor my method, especially since there is a remarkable parallelism in both divisions, Prof. Gill's and mine. This fact suggests that an agreement of both is at least possible, and then, perhaps, some of the scientific terms of Prof. Gill would have the priority and should be used, as most of the terms used by me are certainly in that particular sense of more recent date.

ARNOLD E. ORTMANN.

PRINCETON COLLEGE, May, 1896.

'THE CHILD AND CHILDHOOD IN FOLK-THOUGHT.'

TO THE EDITOR OF SCIENCE: In the issue of March 27th Dr. Brinton has dwelled on the literary merits of Dr. A. F. Chamberlain's book 'The Child and Childhood in Folk-Thought.' As, aside from its literary aspirations, the book is intended as a contribution to Anthropological Science, I may be permitted to add a few words from this point of view.

Dr. Brinton has well said that the book represents a vast amount of compilatory work. The author deserves our thanks for having delved in numerous odd books in which we should hardly expect to find information on the subject of childhood, and for having extricated a considerable number of references from ethnological literature. He has thus largely increased the available material on studies of childhood. These references he has conveniently arranged in a bibliographical index.

While this preparatory work is very meritorious, particularly in so far as it refers to uncommon books, the attempt at a scientific arrangement of the material thus obtained does not appear successful. If scientific description was the author's aim it was incumbent upon him to arrange his material from certain points of view in a systematic way. If he desired by inductive methods to investigate certain phenomena it was his duty to array his facts for the purpose of finding the elements common to all of them. His book fills neither the one nor the other requirement.

A characteristic instance of lack of organic connection is the seventh chapter, 'Affection for Children.' The subject-matter treated is as follows: Parental love, the dead child, motherhood and infanticide, the dead mother, fatherly

affection, kissing, tears, cradles, father and child.

The sixth chapter, 'Primitive Child-Study' or 'The Child in the Primitive Laboratory,' embraces the following headings: Licking into shape, massage, face games, primitive weighing, primitive measurements, measurements of limbs and body, tests of efficiency, sleep, heroic treatment.

I believe these two statements show that the points of view, according to which the author has coördinated his material, are based entirely on considerations foreign to it. This is particularly clear in the sixth chapter. The various customs collated there have hardly any psychological connection and can, therefore, not be held to elucidate in any way the mode of thought of primitive man. He neither thinks of studying children—as we are just beginning to do—nor does he subject them to tests. The customs recorded by the author are practiced for a variety of purposes, but, certainly, the fact that they resemble in a general way tests which we might apply does not give us a right to consider them as psychically connected.

Almost the only chapters in which we can find a connecting idea are the philological ones with which the book opens. In these the author makes a compilation of the uses to which the terms 'father' and 'mother' have been put by various people. But here another lack of the whole work becomes particularly glaring. The quotations are gleaned without any attempt at criticism, and much of the material that is offered is not a safe guide to follow, because the observations and investigations of the writers referred to were not sufficiently thorough.

The book is an illustration of the dangers with which the comparative method of anthropological investigation that has come into vogue during the last quarter of a century is beset.

The fundamental idea of this method, as outlined by Tylor and in the early writings of Bastian, is the basis of modern anthropology, and every anthropologist must acknowledge its soundness.

But with its growth have sprung up many collectors who believe that the mere accumulation of more or less similar phenomena will advance science. In every other science the material on which induction is based is scanned and scrutinized in the most painstaking manner before it is admitted as evidence. It is absurd to believe that anthropology is entitled to disregard this rule, which is acknowledged as fundamental in all other inductive sciences. Furthermore, the object of anthropological research being to elucidate psychological laws on the one hand and to investigate the history of human culture on the other, we must consider it a primary requirement that only such phenomena are compared as are derived psychologically or historically from common causes. How this can be done has been shown by no one better than by Tylor. Only the common mistake of attributing any two phenomena that are somewhat alike to a common cause can explain the reasoning that led the author to amass and to place side by side entirely heterogeneous material.

I believe anthropologists, by silently accepting as a contribution to science a compilation like the present made on unscientific principles, will give countenance to the argument that has been brought so often against anthropology as a branch of science: namely, that it is lacking in a well defined scientific method and that, therefore, it is not equal in rank to other sciences.

FRANZ BOAS.

NEW YORK, May 1st, 1896.

THE DISCUSSION OF INSTINCT.

TO THE EDITOR OF SCIENCE: I have been much interested in the letters in your columns on the instinctive activities of young birds. Certain opinions which I hold—and others that the writers suppose that I hold—have been criticised. To explain my exact position, however, would occupy more space than I can reasonably ask you to afford me. May I be allowed, therefore, to content myself with stating that I have in preparation a work on *Habit and Instinct* which will, I hope, be published towards the close of this year. There my own observations will be described and reference will be made to the work of other observers, and there the provisional conclusions drawn from such observations will be discussed. I desire to make this statement, lest my silence should be regarded as discourteous in the coun-

try where I met with so much kindness and such uniform courtesy.

C. LLOYD MORGAN.

UNIVERSITY COLLEGE, BRISTOL, ENGLAND.

THE SUBJECT OF CONSCIOUSNESS.

EDITOR SCIENCE: Referring to the review of my 'Lehrbuch der Allgemeinen Psychologie' in your valuable magazine for September, 1895, which has but recently come to my notice, I sincerely regret that the reviewer should have fallen into so manifest an error as to suppose the 'subject of consciousness' of my 'Psychologie' to be equivalent to 'self-consciousness;' though he expresses himself with some hesitancy when he says 'it seems most nearly,' etc. As I have pointed out in my work, the misunderstanding is quite apt to arise, from the fact that the word 'subject' is often used in the sense of the 'Ego' or 'Self,' as even shown by the reviewer when he says, 'the consciousness of self *or* subject.' But that is just the very sense in which I do *not* use the word 'subject.' With me, the 'subject of consciousness' does not designate the 'Ego' or the 'conscious mental individual,' but only its fundamental unifying general abstract element, which always exists in the closest union with the other element, which I call *attribute* of consciousness, and *with which* it constitutes the individual unit 'consciousness' or 'conscious individual.' When this is distinctly understood it will be impossible to mistake the 'subject of consciousness,' *i. e.*, the psychological foundation of *all* mentality, for 'self-consciousness,' which is but a later development of the *individual* mind, the 'mental *individual*.' It is a source of great satisfaction to me to have been the first to call attention to this fundamental unifying element. I call it 'subject,' though I shall gladly give up the name if any one will suggest another that is not so liable to be misunderstood. In my 'Psychologie' I lay particular stress upon the fact that, if this 'subject' were not originally present in mental life as the unifying element, together with the attributes of consciousness (sensations, feelings, etc.); if, therefore, as the associationists think, mental life were possible without a subject of consciousness, it would be impossible to explain 'self-consciousness,' which makes its appearance later; for it is precisely this self-consciousness, which is based primarily upon the existence of the 'subject' as an element of consciousness; but *for that very reason* it is far from being identical with that 'subject.'

JOHANNES REHMKE.

GREIFSWALD, April 16, 1896.

THE PREROGATIVES OF A STATE GEOLOGIST.

EDITOR SCIENCE: In connection with the communication of Dr. Keyes, published in SCIENCE, April 24th, page 365, permit me to say to any who may have a passing interest in the subject that I sent the impression paper copy of the original manuscript to the Editor of SCIENCE with a copy of the publication as it appeared, with a request that he kept the two for some months in order that any one wishing to look into the matter might have an opportunity to do so and judge for himself whether I wrongfully represented matters in my communication published in SCIENCE of April 3d last. I might also state that I sent Dr. Keyes a copy of the letter nearly three months before it was published, with a statement that I would publish the same if he did not do something to give me credit for that which was mine, but which had been published under his name.

ERASMUS HAWORTH.

A CORRECTION.

IT is unfortunate that although the figure from Dr. Mügge's paper which I reproduced in SCIENCE last week (p. 698) was expressly marked 'top' on one side, it has been inserted upside down by the compositor. In its present position the figure is meaningless and even misleading.

T. A. JAGGAR, JR.

THE ABSOLUTE AND THE RELATIVE.

TO THE EDITOR OF SCIENCE: Your correspondent 'M.,' in the number of SCIENCE for April 24th, raises a new issue with me; one which has only an indirect bearing upon the subject matter of my article on the 'Illusion Concerning Rest.' In that article I attempted to demonstrate that motion cannot be created or destroyed by collision, but that the body in motion can be only deflected thereby. Now my friend abandons that demonstration and

raises another question about the nature of the absolute and the relative in motion, and shows that he entertains an illusion concerning relation. Of this illusion I shall treat hereafter in another article.

If there was but one particle in the world having motion it would change place. Such a particle does not exist alone, for there is a multeity of particles; but one particle can be considered as existing alone. The particle then would change its place because it had motion, and one place can be compared with another; but as in fact there are a multeity of particles there is also position which is a relation among particles and we may therefore define motion as change of position, and as other particles have motion it is a mutual change of position. By comparing the one particle with the many the demonstration of its motion is perfected. By comparing the motion of a molar body with the motion of its particles and also with the motion of the earth it is seen that molar motion may cease, but that this cessation does not end its molecular nor its stellar motions. That a molar body may come to rest only one of its modes of motion must be destroyed, therefore, rest is not the end of all the motion of any molar body but only the stoppage of molar motion. I have pointed out that the creation of molar motion is the deflection of the other motions inhering in the body and also that the destruction of molar motion is also the deflection of other motions in the body, and no scientific man will deny these propositions; but scientific men have believed that the creation and destruction of molar motion involves not only deflection, but also under some circumstances, though not under all, creates and destroys motion as speed. This I deny and challenge any scientific man to demonstrate any creation or destruction of motion; and, more than that, I claim that Newton's law of motion and the doctrine of the persistence of energy both teach that motion cannot be created or destroyed.

To define motion as change of position instead of change of place is advantageous, for scientific men desire to measure motion both as speed and as path; but to measure a quantity and express it, it must be measured in terms of another and expressed in terms of another. Thus it is that science uses the best definitions for its purposes. I would not write for a scientific journal if I did not believe that I was making a contribution to science. In the case of this series of articles I confidently believe that I shall make a contribution to psychology. I desire to explain the nature of certitudes and illusions by explaining specific certitudes and illusions, and finally I wish to explain the law of mental evolution which is the eliminating of incongruous notions and the criterion for distinguishing certitudes from illusions. Now, my friend need not fear that the bottom will drop out of any real science.

The illusion concerning relation is a fundamental notion in idealism. Those who have fully thought out idealism in all its consequences, as Kant seems to have done and Fichte and Hegel surely did, first attempt to resolve all material phenomena into relations, then affirm that the only absolute is found in mind and that all actuality is mind and that the material universe exists only in thought. I shall attempt to show the certitudes and illusions contained in this philosophy, and for this purpose it becomes necessary for me to define, illustrate and demonstrate the absolute, then to define, illustrate and demonstrate the relative, and finally to point out the illusions concerning the absolute and the relative which have existed and which are especially characteristic of metaphysic, but which sometimes exist in science.

That which exists in one and is essential to its existence is absolute, but as there is more than one, that absolute necessarily becomes relative because there is more than one. In the world there is no such thing as a pure absolute and there is no such thing as a pure relative. If there is no absolute there is no world; if there is no relative there is no world. This is one of the fundamental propositions which I am seeking to demonstrate, and for that purpose I am seeking to point out both elements, that the phantasy of metaphysic may be dispelled, and science may not be burdened with illusions. In my article on rest I tried to point out one of these illusions which inheres in all metaphysical reasoning and which lingers

in scientific reasoning in spite of the Newtonian definition of motion and the definitions given to momentum, energy, force and power. Curiously, I find that even some physicists have not mastered these definitions and still entertain the historical illusion concerning the nature of rest. If my demonstration is studied it will be accepted only in case it does not conflict with some other notion, as that about the nature of relation.

Finally, let me present three other propositions: First, to produce rest in one body it is necessary to transmute one mode of motion into another; second, to produce a new mode of motion it is necessary to transmute a part or the whole of some other mode of motion. Both of these definitions are included in the axiom which I have previously given, that motion cannot be created or destroyed. Third, if motion is not both absolute and relative it does not exist.

J. W. POWELL.

SCIENTIFIC LITERATURE.

Life, Letters and Works of Louis Agassiz. By JULES MARCOU. With Illustrations. Two volumes. New York, Macmillan & Co. 1896. Pp. 302, 318.

Mrs. Agassiz's life of her illustrious husband has always been considered a model of what such a biography should be, full and minute where the matters were important, brief where they were trivial, and composed by elimination rather than agglomeration, so that the effect is massive and interesting from first to last. Mr. Marcou seems to have aimed at muchness of matter rather than excellence of form, and the result is a very different sort of book, realistic and abounding in *traits vifs*, but pervaded by a curious commonness of tone, and by a lack of style rather odd in a Frenchman. In his eagerness to supply every detail of date, place, persons present etc., where events are recounted, too many pages are filled with mere statistical enumeration.

Too much is said of individuals who play subordinate parts in the narrative, and who ought either to have been subordinated still more or made more interesting by becoming more prominent. Any attempt on the part of an outsider to give an in-door view, a view *en robe de chambre*, so to speak, of a man whose family is still living, savors of a certain bad taste, and the strained air of familiarity on Mr. Marcou's part ends by displeasing the reader the more, as it frequently appears to be an appearance of knowingness rather than a real knowledge, where minor events and personages are considered.

It offends most in the author's handling of certain persons who, having once been co-workers with Agassiz, had in one way or another ceased to be his friends. Human nature, even when in the wrong, demands something more than this off-hand contemptuous treatment, or else something less in the way of space taken up. The book, moreover, is written most disjointedly, is full of repetitions, and its comments on Agassiz's zoölogical philosophy are sadly beneath the level of the subject. But in spite of these defects—and they are truly grave ones—Mr. Marcou has evidently taken great pains with his volumes, and has achieved a result which probably comes quite near that at which he aims. In spite of his non-idealizing temperament, he genuinely admires his hero; and what with his facts, his broader appreciations, and all his little dabs and touches, the reader gets at last a picture of Agassiz which is both vivid and realistic, and awakens sympathetic admiration far more than any other kind of comment. Agassiz's personality was indeed so immense, his passions so overpowering, his enthusiasms so magnificent, his sociability and friendliness so great, that no other result was possible. His life, in all its phases, becomes inevitably a sort of heroic romance. Never was there so glorious a youth. At 20 he was a great collecting naturalist. At 22, whilst a student at Munich, he had published his folio describing Spix's collection of Brazilian fishes. At 23 he had begun work on his *Histoire Naturelle des Poissons.* At 26 his *Recherches sur les Poissons fossiles* began to appear. At 30 he had proved the 'Glacial Epoch' and received the Wollaston medal from the Geological Society—a unique honor for so young a man. Mr. Marcou catalogues 43 publications from his pen, many of them of the first order of magnitude, before his 31st year. And all this with no basis of support but his

absolute devotion to natural history and faith in his own powers. At Munich, with his naturalist student friends, "almost everything was enjoyed in common; work, pleasure, journeys, pipes, beer, purses, clothes, ideas, political and philosophical, or poetical, and even literary. In fact, it was a constant, enthusiastic, intellectual life, lived at high pressure, lacking in nothing; not even student-duels, and escapades of a more riotous nature after grand 'Kommers.' Agassiz enjoyed, among the students, the reputation of being the best fencer in the various students' clubs * * *. Strange to say, with an allowance of only $250 a year, [he] managed constantly to keep in his pay an artist, Dinkel, to draw fossil and living fishes, and occasionally a second artist, Weber, to draw the Spix fishes and pieces of anatomy. They formed a sort of fraternal association. As Agassiz said, 'They were even poorer than I, and so we managed to get along together.' Their fare was certainly very simple, bread, cheese, beer and tobacco being the main articles. Imagine Agassiz, with his scanty allowance, providing for two artists, besides Carl Schimper and his younger brother, William Schimper. To be sure, Alexander Braun helped much also. But if we suppose that Braun got $300 a year from his father, six young men, between the ages of twenty and twenty-five, had to live upon less than $600 a year, out of which, also, they had to pay for their studies at the University and provide themselves with instruments and books and clothing. Agassiz got a little money from the 'Brazilian fishes' and some other writing, with which he purchased a microscope—a rather expensive instrument—and several books; and he received, as a gift, from Prof. Döllinger, a copy of the finely illustrated work on living fishes by the great French ichthyologist, Rondelet, of Montpelier. The editor Cotta sent him also a considerable number of expensive natural history books. * * * His room was used as lecture-room, assembly-hall, laboratory and museum. Some one was always coming or going. The half-dozen chairs were covered with books, piled one upon another, hardly one being left for use, and visitors were frequently obliged to remove books and put them on the floor; the bed also was used as a seat, and as a receptacle for specimens, drawings and papers. According to Agassiz, the tobacco smoke was sometimes so thick that it might have been cut with a knife. Agassiz was the most prominent among the students. His acquaintance was courted by all. * * * He was considered a most amiable companion, never losing his temper, always smiling and apparently contented and happy. * * * * There is no other example of such a rapid rise to great scientific reputation as Agassiz enjoyed in his thirtieth year. * * * His power of classifying fossils and his success in reducing to order thousands of specimens of fishes, a great many of which were perfect puzzles to everyone, were simply marvellous; and he worked at his herculean task as no man but a man of genius could have done." (Vol. I., pp. 25, 113.)

Probably no one again will ever have as vast an acquaintance with living things as Agassiz possessed. No man will love Nature's forms more passionately. But biological science now expects more help from what the pedagogues call 'intensive' than from 'extensive' study, and her progress will for the present probably consist more in the unravelling of causes and conditions than in the description of new surface facts. Agassiz is the last of the type of great naturalists who took the individual forms of Nature at their simple surface value as living wholes. Causal laws have their nobility of outlook too, but it is of more abstract and sadder sort. 'Die Form ist zerbrochen, von Aussen herein,' we may say with the poet, when we come to deal with recent speculative biology; and those thoughts of God that Agassiz conceived himself to read off so easily were no doubt in form at least more like the real thoughts of God, in being intuitions of fully concrete facts, than are those poor naked forces and processes and logical elements of things with which our later science deals. Some day our descendants may get round to that higher way of looking at Nature again. Meanwhile from this book, as from every possible book about Agassiz, there floats up a breath as of the morning of life, that makes defects of taste and small in accuracies seem of little account. We recommend it therefore to our readers cordially enough.

Fear. ANGELO MOSSO. Translated from the fifth edition of the Italian by E. Lough and F. Kiesow. London, New York and Bombay, Longmans, Green & Co. 1896. Pp. 278.

Prof. Mosso is one of the most eminent of modern physiologists, and he is an Italian. This book bears ample witness to both facts. It is largely occupied with descriptions of the author's ingenious experiments on the cerebral blood-supply, and is written with naïve openness, eloquence and assurance that read more oddly in the English translation than in the original Italian.

The book not only describes the emotions, but also expresses them and appeals to them. It contains graphic descriptions of convivial feasts and death-bed scenes, even of a syphilitic woman and of a head cut off from the body. We are told of the author's feelings at his mother's grave and on which side of the face his sister blushes. The book is expressly intended for the general public, but will probably, in the Anglo-Saxon race at least, contribute less to its instruction than to the morbid appetite already sufficiently fed by the daily newspapers.

The first half of the book discusses chiefly the functions of the brain and spinal cord, and more especially the relation of the circulation of the blood to emotional disturbances. It is well known that we owe to Prof. Mosso the method of measuring the decrease in the volume of the extremities of the body due to congestion of the brain when it is excited by mental activity, the balance showing the movement of blood to the brain, and many other important investigations on cerebral circulation. Mosso's work in this field is of much value and originality, and it is an advantage to have it accessible in English, even though the method of presentation is not very systematic nor scientific.

The second half of the book is concerned chiefly with the expression of the emotions, not being confined exclusively to fear. Mosso argues against the view that the expression of the emotions must of necessity be useful to the individual. As the translation makes him say 'Spencer and Darwin were not physiologists enough.' It is undoubtedly true that certain expressions of the emotions are pathological. Trembling, as an effect of fright, is probably no more useful to the individual than *paralysis agitans*. There are evident limits to the adaptability of the organism. The nervous system best suited to respond to ordinary stimuli may and does fail in the presence of unusual conditions. Mosso does not accept Mantegazza's extraordinary theory that a frightened animal trembles to keep its blood warm, but he holds that this is the reason why its hair stands on end!

The psychology in the book is not such as to warrant serious criticism. Mosso writes:

"We imagine that the impressions of the external world form a current which penetrates the nerves, and without either abatement or check, diffuses and transforms itself in the centers, finally reappearing in the sublime form of the idea; this is the notion of the soul held by the philosophers of remote antiquity; this is the base of modern psychology."

Indeed, the book does not appear quite contemporary; there is no discussion of the relation between pain and sensation, nor of the James-Lange theory of emotions, according to which the expression is the cause of the emotion and not conversely. The heredity of acquired characters is taken as a matter of course. We are told "civilization has remodeled our nerve-centers; there is a culture which heredity transmits to the brains of our children."

The reader who looks for an index will find in its place a twenty-four page catalogue of Messrs. Longmans, Green & Co.'s publications.

J. MCKEEN CATTELL.

Naturwissenschaftliche Einführung in die Bakteriologie: By FERDINAND HUEPPE, University of Prague. 268 pp. C. W. Kheidel, Wiesbaden, Pub.

Books upon bacteriological technique have been somewhat common in recent years but nothing has hitherto appeared, which, leaving out laboratory methods and systematic details, gives a summary of the important discoveries of modern bacteriology. The reputation of the author of the present work as one of the leaders in modern bacteriology is a sufficient guarantee of its value from a scientific standpoint, and the subjects treated are a sufficient guarantee of its interest. To one who wishes to know what bacteriology has accomplished and what prob-

lems are still undergoing solution nothing can serve better than this outline of Prof. Hueppe.

Beginning with a brief yet complete treatment of the morphology of bacteria and their relations to other groups of plants, the author passes to a consideration of their relations to their environment. Valuable sections are given upon the effects of light, temperature, oxygen, poisons, etc. He treats of the effect which bacteria have upon the medium in which they are growing, of the products to which they give rise, as well those produced by the decomposition of the culture medium as those produced by synthesis and as secretions. He deals of the subject of the food necessary for the life of the various organisms, and in this section, in short, gives a general survey of the relations of bacteria to the environment, thus indicating how and why they may play an important part in nature's processes.

A summary of the relations of bacteria to diseases follows. The different types of germ diseases are distinguished and their relations to micro-organisms. The discussion is more than a simple collection of facts. It brings into prominence the distinction between strictly pathogenic bacteria and those which are pathogenic only under special conditions, between those which are always injurious and thus strictly parasites, and those which are normal harmless occupants of the human body, but which occasionally produce trouble. It emphasizes the personal factor in the matter of infection or in preventing the invading organisms from developing. The discussion can hardly fail to clear our notions, since it gives a sharp and happy summary of our present knowledge of the relation of various diseases to parasites and of the individual to the infecting bacteria.

The most novel and original part of the book is the somewhat extended discussion of the causes of disease and the methods which bacteriology is promising as a means of meeting the various diseases. This subject is too comprehensive and too condensed for summary. The author finds the potent cause of disease rather in the organism itself, looking upon the pathogenic organism simply as a stimulus. He succeeds well in disentangling the miscellaneous confusing facts which have accumulated in the last few years upon the matter of toxines, antitoxines, protective and curative serums, immunity, etc., reducing the subject to something like logical completeness. In this section we see much more than simple compilation of facts and can recognize the author's personality in the method of treatment. Even Prof. Hueppe, however, is not able to reduce this matter to anything like clear logic, since our present knowledge is so largely filled with lacunæ. At best, the matter of immunity and toxines must be left with many questions. It is impossible to read this discussion of toxines and antitoxines, nucleins, phagocytosis, active and passive immunity, etc., without having a better notion of the proper bearing of the different phases of the subject.

This work of Prof. Hueppe is useful to two classes of readers. Those who are not bacteriologists, but who desire to learn the general facts which the last quarter of a century has discovered, will find here a brief but intelligible summary. Those who are already familiar with the general facts will, perhaps, find the book of even more value in giving a clear and simplified conception of the various confusing facts which have so rapidly accumulated in recent years.

H. W. Conn.

SCIENTIFIC JOURNALS.

THE ASTROPHYSICAL JOURNAL, APRIL.

The opening article, by Prof. J. Wilsing, contains a short discussion of previous papers on the law of the sun's rotation. The differential currents on the sun's surface are shown to be results of earlier conditions of motion, and can be destroyed by internal friction only. The least time in which changes of the surface currents would become perceptible is calculated to be millions of years.

In a report on solar observations for the second half of 1895, by Prof. Tacchini, there is shown a continued decrease in the number of spots, with a secondary minimum in November. There was a disproportionate decrease in prominences with a minimum in October.

In discussing the spectrum of Mars, Prof. Lewis E. Jewell contends that spectroscopic proof of the presence or absence of water in the

atmosphere of Mars must be regarded as unattainable. With reference to oxygen, its presence might possibly be detected if present to the amount of a quarter that in the earth's atmosphere.

In an article on A New Form of Refractometer, Mr. C. Pulfrich describes one with a scope of application including almost all quantitative investigations on refraction and dispersions at varying temperatures. Its essential features consist of a 90° prism, one face of which, turned upward and made horizontal, is brought in contact with the object to be investigated, while through the vertical face is observed the boundary line limiting the light which, after passing through the object, enters the prism under grazing incidence.

The latest article in the series on the 'Modern Spectroscope' is by Professor Newall. It is a description of the new Bruce spectroscope constituted for the Cambridge observatory. The instrument is unique in being designed solely for photographing spectra of the fainter stars and in having no provision made for visual micrometric measurements. A single white-flint prism is used, giving a spectrum of 20mm. in length between $H\beta$ and K, or, with a telephoto-combination, a spectrum of about 44mm.

Other articles are, 'Light Curves of Variable Stars Determined Photometically,' by Edward C. Pickering; 'The Arc Spectra of Rhodium Ruthenium and Palladium,' by Henry A. Rowland and Robert R. Tatnall.

Among the minor contributions is found a concise summary of the properties of the X-rays and a comparison of them with those of light and cathode rays; and a recommendation that, in place of mercury as a reflecting surface for sextant and other work, a dark cylinder oil be used, such as may be procured of any locomotive engineer. It is freer from vibration, cheaper, lighter to carry, and easier to obtain in out-of-the-way places.

THE AMERICAN GEOLOGIST, MAY.

The Genus Temnocyon and a New Species thereof and the New Genus Hypotemnodon, from the John Day Miocene of Oregon: By JOHN EYERMAN. The new species described is *Temnocyon ferox*, of which a very complete and detailed description is given. The new genus *Hypotemnodon* is proposed for the reception of Cope's *Temnocyon coryphæus*.

Early Pleistocene Deposits of Northern Illinois: By O. H. HERSHEY. The author discusses the glacial geology of a part of northern Illinois, especially the Pecatonica valley, in which was formed a glacial lake named Lake Pecatonica.

On a Supposed Discovery of the Antennæ of Trilobites by Linnæus in 1759: By C. E. BEECHER. In the Geological Magazine for March, Törnquist calls attention to a discovery, by Linnæus, of the antennæ of *Parabolina spinulosa*, which has apparently been overlooked by later workers. Dr. Beecher not only shows that this discovery has not only been overlooked, but also that what Linnæus considered as antennæ are not antennæ at all.

The Deposition of Gold in South Africa: By S. CZYSZKOWSKI. (Translated by H. V. WINCHELL.) The theories advanced by de Launay, Jules Garnier and others to explain the origin of the auriferous beds of South Africa are not in all respects acceptable. Instead of the contemporaneous deposition of gold and mechanical sediments of conglomeratic nature it is held by M. Czyszkowski that the gold was introduced by mineral waters circulating through the porous strata subsequent to their consolidation, and as an accompaniment of a period of general earth movements and eruptive phenomena. The auriferous strata are believed to occupy synclinal basins in which the gold ores have been developed in favorable situations. Summarized descriptions of the geology of South Africa are given, and several comparisons are made between these ore deposits and those of Spain. The introduction of the gold is believed to have been of Carboniferous age, and prior to the formation of the Cape diamonds. From a more detailed discussion of the geological structure of the several Transvaal districts it is inferred, on the one hand, that the ore deposits may be far from inexhaustible; while, on the other hand, it is shown that there are many more geological conditions and other horizons which appear to be favorable for the concentration of gold ores, and where explorations may be conducted with profit.

Minerals and the Röntgen Rays: By W. G. MIL-

LER. The author presents some notes on X-ray photographs of minerals and thin sections of rocks; the article is accompanied by an illustration.

SOCIETIES AND ACADEMIES.

ACADEMY OF SCIENCE OF ST. LOUIS.

At a meeting of the Academy on May 4th Prof. Nipher read a preliminary paper on *A Rotational Motion of the Cathode Disc of the Crookes Tube.*

He had been studying the change in the character of the Crookes effects due to long continued operation. It was observed that the cathode disc of aluminum was slightly loose, and that it was rocking to and fro in rotary motion on the aluminum wire. It finally became loosened and started into a slow rotation. The motion was a halting one, as the disc was out of balance and the bearings were rough. When stopped by pinching in the bearing, it began to struggle and rock against the restraint and would finally become loosened again and continue its motion.

It was impossible to either accelerate or retard the motion by powerful bar magnets, applied as in Barlow's wheel. Change in position with respect to the earth's field or the induction coil produced no effect on the rotation. Looking at the disc from the point where the cathode wire enters the tube, the disc rotates counter clockwise. The brush discharge of a Holtz machine yielded even better results than the induction coil when the leading conductors were separated by spark intervals.

The rotation has not yet been obtained between spark terminals in air of ordinary pressure nor when the movable disc forms the anode, but work on these points is not yet concluded.

Prof. Nipher stated that the experimental evidence thus far indicates that the effect is due to action and reaction between the cathode plate and the radiant matter. If so, the radiant matter starts from the disc in a vortex, whose axis passes through the dark spots opposite the disc faces. It may also be due to direct action and reaction between the disc and the surrounding field due to the current. He is now having apparatus constructed which will determine between the possible explanations. Prof. Nipher stated that he had long sought some experimental basis for imposing a condition of rotation upon the equations for force and potential within a wire conductor. Without such term the equations lead to absurd results.

Dr. E. C. Runge described an interesting case of insanity, unrecognized for twenty-eight years.

William Trelease,
Recording Secretary.

NEW YORK ACADEMY OF SCIENCES.—SECTION OF ANTHROPOLOGY, PSYCHOLOGY AND PHILOLOGY.

The Academy met on April 27th, with President Stevenson in the chair, and proceeded to organize the new Section in Anthropology, Psychology and Philology. Prof. N. M Butler was chosen temporary chairman.

Prof. F. H. Giddings was nominated and elected Permanent Chairman of the section; Dr. Livingston Farrand, Secretary of the sub-section of Anthropology and Psychology, and Prof. A. V. Williams Jackson, Secretary of the sub-section of Philology. The officers were elected for a term that will end at the annual meeting of the Academy, and it was resolved that the two sub-sections meet in alternate months.

Prof. F. H. Giddings read a paper on *A Plan for the Systematic Study of tribally organized Societies*, which will be printed in Science.

Prof. J. McKeen Cattell described a *Method for Determining Photometric Differences by the Time of Perception.* A series of gray surfaces was exhibited making over 200 nearly equal shades between black and white. The shades are so nearly alike that they cannot be distinguished with certainty, and when the observer attempts to sort them out in order an error of displacement occurs which measures his accuracy of discrimination. With nine observers the error varied from 6.04 to 11.05, the average being 8.1, from which it follows that about 25 shades can be distinguished between black and white. The relation of the error of observation to the brightness of the light was shown. The speaker further described experiments now being carried out with the same gray surfaces, in which the time it takes to distinguish the difference between two sensations is used to measure

the amount of difference in intensity between the sensations.

Dr. Livingston Farrand, in a paper on *Primitive Education*, discussed methods of training and general education among primitive peoples in their bearings on primitive conceptions of morality, taking up the general condition of the child in the savage community and more particularly the relations of the child and parent.

The question of education was discussed under three heads: (1) the natural training which the child obtains by natural reaction on his environment and without definite instruction by his elders; (2) the practical education where the child is definitely instructed in the arts which will be of use to him in his later, life and (3) his ethical education. Attention was called to certain phases of the subject where observations are particularly faulty or altogether wanting.

Dr. Franz Boas spoke on the *Correlations of Anthropometric Measurements*. He pointed out that when any two biological measurements are considered as correlated, and individuals showing a certain value of the first measurement are grouped together, then the average of the values of the second measurement for the group of individuals will also be changed, but to a less degree than the first. When, however, the grouping of individuals is made according to social aspects, then all the measurements change either proportionately or according to laws differing from the one quoted before, the reason being that in the second grouping a certain set of causes influence all the measurements in the same manner. By applying this principle it is possible inversely to determine social causes that produce certain anthropometric peculiarities, as in groupings which are made according to the proportions and to the absolute values of measurements combined, the social classes will be represented in varying proportions.

LIVINGSTON FARRAND,
Secretary of Sub-section.

PROCEEDINGS OF THE TORREY BOTANICAL CLUB WEDNESDAY EVENING, APRIL 29, 1896.

THE Club met as usual in Hamilton Hall, with President Brown in the chair. There were present 64 persons.

Dr. Britton reported a successful field meeting at Prince's Bay, S. I., on April 25th, it being the first of the season.

Major Timothy E. Wilcox's paper, 'Botanizing in Arizona,' was then read. It was drawn from experience during four years residence at Fort Huachuca and was devoted to climate, seasons and topography, as well as descriptions of some of the little known plants of that locality. Botany was treated from an economic standpoint as well as otherwise. Lantern slides from original photographs were exhibited. Also slides showing other scenes were introduced.

Mr. Cornelius Van Brunt then rapidly showed a number of colored lantern slides of plants growing in Central Park, accompanying them with short descriptions and anecdotes. Most of these slides had not been exhibited before. Mr. Van Brunt described the method of coloring these slides by the use of aniline colors applied by hand.

W. A. BASTEDO,
Secretary pro. tem.

GEOLOGICAL CONFERENCE OF HARVARD UNIVERSITY, APRIL 14, 1896.

On the Function and Systematic Importance of the Aptychus in Ammonites. By C. R. EASTMAN.

The speaker described the nature and mode of occurrence of the aptychus, and exhibited several specimens with the aptychus preserved in the so-called 'normal position' and also directly at the aperture. The numerous theories regarding its function were discussed, principal attention being paid to the nidamental and operculate theories. The Dundry, Crimean and Solenhofen specimens described by Owen, Retowski and Michael, respectively, were next discussed, and these were shown to prove, beyond all doubt, the operculate function of the aptychus. The fact that aptychi do not represent the calcified head cartilage of Dibranchiates was used as an argument against Ihering's proposition for associating Ammonites with the latter group. The viviparous habit of Ammonites, as indicated by the discovery of a number of minute aptychi and shells within the living chamber of *Oppelia steraspis* was commented upon, and attention called to the fact that in the Upper Jurassic Ammonites, which were then entering upon their decline, the de-

velopment of the aptychus was initiated in the earliest shelled condition. The affinities between the Ammonites and Dibranchiates were shown to be on the whole very close, yet the evidence furnished by their internal structure and shell development is so strongly in favor of the Tetrabranchiate character of Ammonites that their separation from the Nautiloids seems at present unwarranted.

The Quartz Porphyry and Associated Rocks of Pequawket Mountain (the eastern 'Kearsarge' of New Hampshire). By R. A. DALY.

Both of the geological surveys of New Hampshire noted the presence of the remarkable flow breccia outcropping on what was long called 'Pequawket Mountain.' The second survey placed it in their table of formations under the name of the 'Pequawket Breccia.' The mountain is chiefly composed of a typical quartz porphyry in which inclusions of various rocks lie embedded. The object of this paper was primarily to present the results of an examination of a large number of microscopic slides prepared with the purpose of tracing the extent to which the inclusions had suffered from the metamorphism of the igneous body. The great slate mass on the south side of Kearsarge, is a gigantic horse in the poryhyry. It is about four hundred yards long from east to west and one hundred and fifty wide and lies close against the contact of the older 'Albany Granite.' On the border of the slate, severe brecciation has been produced, some phases being composed entirely of aggregated slate fragments, others with a variable proportion of quartz porphyry cement. Throughout the mountain small inclusions of the same phyllitic slate, from two feet to a fraction of an inch in diameter, are exceedingly numerous. Now, the striking fact in connection with them is the almost absolute lack of metamorphic change which has affected these fragments. The great horse of the south side does not betray any marginal alteration, except in the physical way already noted. This is a marked exception to the general conclusion of Lacroix that chemical rearrangement is usual in bodies enclosed within volcanic rocks of his 'trachytoïde' type. (Mem. de l' institut de France t. XXXI., 1894, p. 81.) It is all the more remarkable on account of the fact that the field-evidence shows the porphyry to be not a surface flow, but the filling of a neck where we should expect high temperatures and pressures and the presence of mineralizers to have produced extensive alteration.

The contemporaneous porphyry of Moat Mountain is in a similar tectonic relation and is likewise filled with inclusions of the same general nature as those of Kearsarge. Here also the metamorphism is almost *nil*. It is of interest to note that the base is not vitro-phyric as in the Kearsarge rock, but granophyric with accessory crystalline ingredients. Besides the phenocrystic quartzes and microperthitic feldspars, the rock is composed of a dense microgranitic matrix of quartz and feldspar, with abundant minute grains of hornblende, titanite, zircon, apatite and primary fluorite. This composition allies the rock closely to the 'Albany Granite,' which is, in part, the country rock of these porphyries.

The eruptions occurred after the last important White Mountain uplift. The eruptives are not squeezed, and their inclusions are, in part, derived from the crystalline schists, of the Montalban terranes. The slates, sandstones and phyllites probably represent masses which have sunk to their present level in the vent from the superficial zone of minimum metamorphism during the mountain building. It is, however, conceivable that they might have been carried up from a zone which lay below the level of no strain at the time of plication.

T. A. JAGGAR, JR.,
Recording Secretary.

PHILOSOPHICAL SOCIETY OF WASHINGTON.

AT the regular meeting, on April 25th, the following papers were presented, both being extensively illustrated with photographs of buildings in various parts of the world and plans and designs for the Capitol and Executive Mansion in Washington, the one by Wm. Martin Aiken on the 'Influence of Climate on Architecture,' and the other by Mr. Glenn Brown on 'Early Government Architecture.'

BERNARD R. GREEN,
Secretary.